THE

PRINCIPLES AND PRACTICE

OF

SURGERY

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SECTION IV

SURGERY OF THE VASCULAR SYSTEM

IN this section are considered the blood and lymphatic vascular systems with the exception of the heart, which is more conveniently dealt with in the section on Surgery of the Thorax.

CHAPTER XVII

THE BLOOD-VASCULAR SYSTEM

Hæmorrhage—Varieties : Signs and Treatment : Saline Infusion : Reactionary and Secondary Hæmorrhage : Embolism and Thrombosis : Hæmophilia : Injuries of Blood-vessels : Arteries, Veins : Arterio-venous Anastomosis : Inflammations and Degenerations of Arteries : Aneurysm : Varieties : Diagnosis and Treatment : Operative Measures : Treatment of Special Aneurysms : Aorta : Carotid : Intracranial : Subclavian Axillary : Inguinal and Iliac : Popliteal. Veins—Phlebitis : Varix : Nævi : Cirsoid Aneurysm : Operations on Blood-vessels : Suturing, Anastomosis, Ligature of Vessels : Ligature of Special Arteries.

SINCE the vascular system is an arrangement of tubes through which, by means of the pumping action of the heart, blood is conveyed to the various tissues and organs of the body, it is clear that affection of any part of this system may lead to general effects on the body either (1) by escape of blood from the containing tubes, from some local affection causing leakage, or, in other words, hæmorrhage ; (2) some substance other than normal blood may obtain entrance to the blood-passages or be formed there by processes of disease and be carried to distant parts of the body, producing effects varying with its nature. Such abnormal constituents circulating in the blood are called *emboli*, and when in their travels they reach some part of the blood-channel where their size does not permit them to pass, they become lodged there, and this process is called *embolism*. A consideration of these general affections of the blood-vessels, hæmorrhage and embolism, forms a useful introduction to this section.

HÆMORRHAGE

By this term is meant an escape of blood from the vessels, whether outside the body from the surface or into one of its cavities, *e.g.* the peritoneum, cranium, or intestine. The underlying cause may be an injury, penetrating the coats of the vessels, or acquired disease, causing them to

become soft and give way under the normal or increased pressure of blood inside ; in some instances the hereditary disease hæmophilia is responsible.

Various terms are used to denote the escape of blood in different parts and under different conditions.

External or manifest hæmorrhage means escape of blood on the outside of the body.

Internal or concealed hæmorrhage is where the escape of blood is into one of the body-cavities, in which case it may become manifest if vomited or coughed up, if in the lung or stomach, or may remain concealed till revealed by operation, as in the pleura or peritoneum.

Extravasation implies a diffuse escape of blood into the tissues. Ecchymosis is applied to a superficial extravasation, commonly known as a bruise. Where an extravasation of blood is large and well defined, forming a marked swelling, it is called a " hæmatoma." Small point-like ecchymoses are called petechiæ. The escape of blood from internal cavities is known by various terms.

Hæmoptysis is an escape of blood from the lungs when it is coughed up, and is bright red, frothy, and liquid.

Hæmatemesis is the term used when blood is vomited up from the stomach, whether from erosion of vessels of the stomach or having been previously swallowed, from bleeding in the mouth, nose, &c. In this case the blood is dark and clotted like raw liver, or, if partially digested and in smaller amount, may have the appearance of " coffee-grounds."

Hæmaturia implies escape of blood in the urine, whether derived from penis, bladder, or kidney (Urinary Surgery).

Blood coming from the rectum is of two distinct varieties. When derived from the wall of the rectum or large intestine it may be liquid or clotted, but is dark red and obviously but slightly altered ; when coming from the intestinal tract high up, especially from the stomach or duodenum, the blood is altered by digestive processes so as no longer to resemble blood but is black, and the motions appear " tarry " and often iridescent. The passage of such altered blood is known as " melæna," and is an important indication of disease of the stomach or upper part of the small intestine.

Further, bleeding is distinguished, according as it issues from arteries, capillaries or veins, and this can only be done with any certainty where the hæmorrhage is external ; should hæmorrhage be subcutaneous, we may infer that it is of arterial origin if the swelling increases rapidly, assuming a notable size in a few minutes. The origin of external bleeding is readily decided as follows :

(1) Blood escaping from a leak in a divided artery is bright scarlet in colour unless the patient is asphyxiated (as may occur under indifferent anæsthesia), and escapes in forcible jets, spurting to a height of one to three feet, dependent on the size of the vessel and the blood-pressure. These spurts are intermittent and synchronous with the heart-beat and pulse, but if the wounded vessel be in a deep wound the intermittence may not be obvious.

(2) When the blood is of venous origin it is dark, if from large veins

black, and usually wells up steadily, but if the patient be partially asphyxiated may spurt to a considerable height, since when the chest is held rigid the intravenous pressure becomes nearly equal to that inside the arteries. Such spurting from veins, however, is constant and not intermittent as in the case of bleeding from arteries. Divided arteries and veins bleed from both ends as a rule, but arteries most from the proximal, veins from the distal end.

(3) Capillary bleeding, with which is included that from minor arterioles and venules, is a general oozing not coming from any one point, and the colour of the blood is intermediate between the scarlet of arteries and the dark colour of venous blood. Capillary bleeding readily ceases except in hæmophilics.

Hæmorrhage is further divided according to its incidence in point of time after the exciting cause (wound, &c.), into :

(1) Primary, which occurs immediately on the receipt of the injury.

(2) Intermediate, following within twenty-four hours.

(3) Secondary, which follows the lesion after an interval of a week to ten days. Intermediate and secondary hæmorrhage are practically always of arterial origin, and their meaning will be detailed later.

RESULTS OF HÆMORRHAGE. These are local and general.

(1) *Local.* Should the blood escape freely on the outside of the body the local effects are nil, but if the hæmorrhage be internal it will press on surrounding parts and may cause trouble, *e.g.* when the popliteal artery is ruptured the effused blood may press on the vein and so obstruct the latter that the circulation of the leg is greatly impaired and gangrene ensues ; inside the skull hæmorrhage may lead to compression of the brain ; inside the pericardium the heart's action may be impeded and eventually stopped by effusion of blood, nor need the effusion be great to cause such pressure effects.

(2) *General.* The main general effect of hæmorrhage is to lower the arterial blood-pressure by diminishing the amount of blood. The amount of blood normally present in the vessels is in excess of what is needed to maintain the blood-pressure, and a certain proportion may be lost without appreciably affecting the blood-pressure, but after a pint or so (varying with the patient) has been lost the blood-pressure falls considerably and the parts most dependent on a constant supply of fresh blood show signs of failure. The brain is the organ which suffers most when the blood-pressure is suddenly lowered in this manner, and failure of nutrition here rapidly results in syncope and death. The severity of the symptoms depends rather on the loss of fluid in the circulation than loss of blood-corpuscles. Thus a patient bleeding slowly and intermittently, *e.g.* from hæmorrhoids, may be white or greenish in colour from the small amount of hæmoglobin (corpuscles) in the blood and yet be able to get about quite well, whereas if the blood be removed suddenly by a severe hæmorrhage, although the amount of hæmoglobin left is much greater than in the former condition, the patient suffers from severe and even fatal syncope.

We must therefore separate acute from chronic or intermittent, small

hæmorrhages, and it is the former which is considered in this section. Suffice it to state that chronic bleeding is one of the causes of anæmia, the signs being pallor, shortness of breath on exertion, swelling of the feet, and changes in the constitution of the blood, fully described in medical works. The anæmia due to gastric, duodenal or hæmorrhoidal hæmorrhage is of this nature.

General Signs of Acute Hæmorrhage. The local signs have been mentioned under arterial, venous, and capillary bleeding. The initial general signs are pallor and faintness, which are in many instances not due at first to loss of blood, which may be trifling, but are of psychic origin, the sight of blood, especially coming from their own bodies, having a depressing effect on many persons. Should, however, the bleeding continue, these signs are really due to the loss of blood and falling blood-pressure, and the patient has other signs of syncope, losing sight and hearing, becomes unable to stand, falling prostrate (Nature's device to secure a better supply of blood to the ex-sanguine brain). The respiration becomes deep, prolonged, and sighing, the patient feeling that he cannot fill his lungs full enough (this condition of air-hunger is characteristic of severe bleeding, though also found in toxic conditions such as acidosis, and signifies a grave condition of the respiratory and other cerebral centres). The pulse becomes rapid, small, soft, finally disappearing in the smaller vessels and only felt in the large trunks, e.g. the carotid. Where the condition of syncope is not so marked the patient complains of severe thirst, of rushing noises in the ears, flashes of light and black spots before the eyes, which are the prelude to unconsciousness. The skin is cold and damp with sweat, the pupils dilated. Often the patient is restless, throwing the arms about. The sphincters relax, and convulsions may usher in the final exit. Children stand loss of blood badly, but recover rapidly once past the danger-point. Women endure bleeding far better than men, doubtless from habit. These general signs of hæmorrhage are of the utmost importance, since internal, concealed bleeding is a most grave condition and only to be recognized by general signs, and unless recognized early is likely to prove fatal, but if diagnosed and treated by adequate surgical measures these patients form one of the most satisfactory groups of cases in the whole of surgery, when we consider such conditions as rupture of ectopic gestations, ruptured kidneys, spleen, and to a less degree, bleeding from gastric and duodenal ulcers.

Diagnosis. When external the matter is clear at a glance, but where the blood is poured into some cavity of the body (*i.e.* is concealed) diagnosis may need considerable care in the early stages (and it is the early stages which are likely to be treated successfully). A consideration of the general signs of hæmorrhage will show that the condition most likely to be mistaken for this is shock or collapse ; moreover, the conditions are often combined, and both are associated with a sudden fall of the arterial blood-pressure. The pallor is more noticeable in hæmorrhage than shock, and in the latter state the senses are generally clear, the subjective auditory and visual

sensations noted in hæmorrhage being absent. In cerebral concussion (a variety of shock) there will be a varying degree of unconsciousness. The respiration in case of shock is quiet and shallow, not deep sighing or with the air-hunger of severe hæmorrhage, nor is the patient restless, flinging the arms abroad, in the former condition, but is quiet and motionless. Thirst is a far more marked symptom from hæmorrhage than shock.

NATURAL ARREST OF HÆMORRHAGE. The ultimate cure of bleeding is by sealing of the leaking vessels, in the first instance by clotting of blood inside the vessels in the neighbourhood as far as the branch next to the site of hæmorrhage. The clot is later converted into fibrous tissue, forming a scar as in healing elsewhere. Conditions tending to assist these curative processes are :

(1) A fall of blood-pressure, which is the constant result of much bleeding and renders the outflow of blood slower, giving more time for coagulation to take place in and around the injured vessel.

(2) Changes in the wall of the wounded vessel, especially applying to arteries. An artery when cut across retracts into its adventitial sheath, the intima curling inwards and thus diminishing its lumen, which is still further lessened by contraction of the circular muscular fibres of the vessel. Where the artery is only partially cut across this retraction cannot take place and bleeding continues longer. This power of retraction accounts for cessation of hæmorrhage from small arteries cut clean across, but is insufficient to check the bleeding from larger vessels.

(3) Clotting in and around the vessel at the site of injury also closes the leak temporarily, but this blocking is not very firm, and in the case of arteries may be broken down, when the blood-pressure rises again (as will occur as the patient recovers from syncope). This takes place in the first few hours after injury and causes fresh bleeding, known as reactionary or intermediate hæmorrhage. Later, after some days, the clots, instead of cicatrizing, may break down from infection with pathogenic organisms, when bleeding again takes place, then known as secondary hæmorrhage.

TREATMENT OF HÆMORRHAGE. As bleeding may be of accidental origin or due to surgical interference (the latter being far more common in civil practice), we must consider the prevention of hæmorrhage, its local treatment both in operative and accident cases, and methods of dealing with the general effects of this suddenly produced anæmia.

(1) *Prevention of Hæmorrhage in Surgical Operations.* Where an operation is being conducted on one of the extremities the elastic tourniquet is a convenient method of preventing bleeding. The limb is elevated for a minute to allow the venous blood to escape into the circulation and the tourniquet applied as described under Amputations.

The disadvantages of using a tourniquet are that if the operation be prolonged the deprivation of blood for this period may lead to ischæmic contracture of the muscles of the limb (this is unlikely unless the anæmia be maintained for over an hour and a half) ; also there is more likelihood of prolonged oozing from cut surfaces after the use of a tourniquet.

Occasionally nerves may be pressed on should the tourniquet be applied with excessive zeal. For regions of the body where the tourniquet cannot be applied, the surgeon relies upon his knowledge of anatomy either to place a temporary clamp or permanent ligature on the large vessels early in the operation, or ties or clamps vessels or any part which may contain vessels before dividing them. This applies especially to operations in the neck—above all, on goitres.

The rapid picking of vessels inadvertently divided is essential : no patient should be allowed to bleed freely during an operation, as bleeding increases shock and collapse. Digital pressure may also be employed for controlling large vessels as a useful training for students.

(2) *Arrest of Hæmorrhage.* The means employed are similar for accidental and surgically induced bleeding. and these may be considered together ; in addition, however, to the means employed by the surgeon, there are to be considered the methods available when a case of hæmorrhage is encountered, at its onset, no instruments being available, *i.e.* first-aid for hæmorrhage.

First-Aid. (*a*) For internal, concealed hæmorrhage there is but little to do except that the patient should be kept quiet and morphia administered (where the diagnosis is tolerably certain), and means of transport should be arranged as soon as possible to some place where operative measures may be undertaken when the case is suitable.

(*b*) There are two methods of dealing with external bleeding which should be known to the public.

(1) Elevating the part which is bleeding. This is especially available for bleeding from the leg and for venous bleeding (*e.g.* ruptured varicose veins, a common source of hæmorrhage). If the limb be raised, the patient remaining recumbent, most of the bleeding will cease at once. Many lives have been lost from ignorance of this simple fact.

(2) Pressure over the bleeding-point made with the hand or finger or, better, with a plug formed of a clean handkerchief or other clean linen (which is relatively aseptic). This, rammed into the wound and firmly bandaged in position, will prevent most bleeding even from large vessels. Tourniquets are useless except in skilled hands, being seldom applied tight enough and usually placed above the wound in the case of venous bleeding (the " man in the street " always imagines that severe bleeding is arterial), rendering the hæmorrhage worse, and when removed the bleeding mostly ceases, much to the surprise of the worthy constable whose well-intentioned but ill-directed efforts have not been crowned with success. A tourniquet applied tight enough to prevent arterial bleeding is extremely painful, and should only be used by one who has a practical knowledge of surgery. Digital pressure on the main artery is a serviceable method, though very tedious for the person who controls the vessel.

Points at which to exercise Digital Pressure. The arterial circulation in the lower limb may be arrested by pressing just above Poupart's ligament, midway between the symphysis pubis and the anterior-superior spine of

the ilium. The artery is readily felt pulsating at this point and is compressed against the pubis.

The circulation in the arm can be arrested by pressing firmly downwards behind the clavicle, just outside the clavicular origin of the sternomastoid, when the subclavian artery is felt pulsating and can be compressed against the first rib. The brachial can be readily controlled by pressing this vessel out and back against the humerus in the upper third of the arm, as it lies under cover of the inner edge of the biceps muscle.

SURGICAL TREATMENT OF HÆMORRHAGE. This depends on the variety, whether capillary, venous, or arterial.

(1) Capillary hæmorrhage usually ceases of its own accord while an operation is being performed. Should oozing prove troublesome (which implies that the bleeding is from small veins and arterioles and not merely of capillary origin), there are several methods available.

(a) Pressure may be applied in the case of a limb by firmly bandaging over a quantity of dressing to distribute the pressure, retaining a drainage-tube in the wound for twenty-four hours. Where firm bandaging is not feasible, as in the neck or the abdomen, pressure may be applied in the case of a localized cavity by plugging gauze into the latter, which is retained for twenty-four hours.

(b) The vessels may be made to contract by irrigation with very hot lotion (120° Fahrenheit). This method is suitable for cavities in which plugging with sterile gauze is not indicated, such as the bladder and uterus, as well as for amputations and other large wounds. Another plan is to pack for a few minutes with gauze soaked in adrenalin solution 1 in 1000, which also causes contraction of blood-vessels.

In addition, hypodermic injections of ergotine may be given to assist further in producing contraction of the vessels and muscles of the organ where hæmorrhage is taking place. This is especially indicated for uterine hæmorrhage, but is also serviceable in the case of the bladder.

(2) *Bleeding from Definite Vessels, whether Arterial or Venous.* Small arteries divided in small wounds, especially if near bones, as in the case of the temporal artery or the posterior tibial, divided in performing a teno-tomy, as well as small veins, may usually be controlled by firm bandage over a pad of dressing. But where larger vessels are divided, or where the vessels are cut in large open wounds, each bleeding-point must be arrested separately. The chief plans of controlling bleeding-points are the ligature with its modifications and crushing, but plugging the cautery and styptics are sometimes useful.

(a) *The Ligature.* This is the most generally serviceable method, the vessel being first secured with catch-forceps (Spencer-Wells or other type); the ligature should be tied with a reef-knot. Where the ligature may readily slip and important vessels are being tied, *e.g.* in the omentum or the pedicle of an ovarian cyst, the mass of tissue surrounding the vessel should be trans-fixed and the ligature tied on one side and then brought back and tied round the whole pedicle, thus effectively preventing any chance of slipping. In

other instances the ligature may be passed round a large vessel with an aneurysm-needle, the double thread divided, and the vessel tied in two places half an inch apart and divided between. In other places, again, the ligature is passed round the place to be tied with a suture-needle till the latter is well surrounded and then the ligature tightened. This is suitable for bleeding from inside the stomach or in the brain or meninges.

For ligaturing small vessels absorbable catgut is sufficient. In the case of large main arteries of limbs, e.g. the femoral, it is safer to use chromicized catgut, for if absorbed too rapidly secondary bleeding may take place. Where there is some chance of the ligature slipping it will be best to use fine silk ; this is especially the case when a lateral ligature is applied to a vein which has been punctured or partially divided.

Small, easily caught bleeding-points are secured with catch-forceps as the operation proceeds, and if interfering with manipulation, tied in batches as required or at the close of the operation.

(b) *Crushing and Torsion.* The former consists in catching the bleeding-points as mentioned and removing the forceps without tying at the end of the operation ; many vessels are thoroughly occluded by such crushing (forci-pressure) ; but to render the matter safer the forceps should be twisted several times till the vessel and surrounding tissue are felt to be weakened, but not twisted right off or hæmorrhage will often commence again. This is less certain than ligaturing, and if bleeding commences after the twisting the bleeding-point will need catching again. Therefore twisting is only recommended for quite superficial vessels in the skin.

A modification of crushing is employed for bleeding from bone, especially in the case of the skull, where the edges of the bone are crushed together, effectually obliterating any vessels in between.

Plugging is available under several conditions ; aseptic gauze may be packed tightly into a cavity as for capillary oozing. In other instances where an artery emerges from a bone the vessel and the hole in the bone may be blocked with a plug made of a spicule of bone detached elsewhere, or a piece of thick catgut may be forced in. These plans may serve for securing the middle meningeal artery as it emerges from the foramen spinosum inside the skull. The most generally useful plan of this sort is the use of aseptic wax or paraffin of medium hardness (Horseley), which is forced on to the cut surface of the bone, e.g. of the skull, and sticks firmly in the irregularities, so preventing any bleeding.

The cautery is seldom used in modern surgery to check hæmorrhage owing to the sloughs and sepsis induced, but it is useful in certain places ; thus the small bleeding ulcer of the nasal septum is most readily sealed with a touch of the electric cautery or a bead of chromic acid fused on the tip of a probe. Styptics or agents to produce clotting of blood, such as perchloride of iron, are no longer used, being messy and ineffectual : for there is little advantage in obtaining a mass of clot about the bleeding vessel, under which hæmorrhage often continues, and which itself is a fine breeding-ground for all manner of bacteria. As far as clotting is concerned we should

aim at promoting coagulation inside the vessels by diminishing or obliterating their lumen as described ; and the liquid agents employed to prevent bleeding act in this manner, including hot water and adrenalin. Turpentine is a useful antiseptic and hæmostatic acting in a similar manner, and, being found in every household, may often be employed in cleansing and checking the bleeding from dirty wounds.

Suture of vessels is a most useful method of checking hæmorrhage under certain circumstances, and is described later (Arteries).

(3) *Treatment of the General and Constitutional Effects of Hæmorrhage.* The main end in view is to restore an efficient blood-supply to the depleted brain, partly by increasing the blood-pressure, partly by rendering the flow to the brain more easy. The procedure will differ according as to whether the source of hæmorrhage has or has not been effectively checked. In most cases under surgical care some attempt will have been made to find the source of bleeding and prevent further loss of blood taking place. Where, however, the bleeding has not been controlled, *e.g.* in a case of general oozing from the stomach, the blood-pressure should be as low as possible compatible with life, as giving more chance of clotting in the vessels around the bleeding-point and cessation of hæmorrhage. Consequently, in such conditions little more can be done than to keep the patient quiet with morphia and, by raising the foot of the bed, to promote circulation of blood in the brain. Infusion of saline or other methods of raising the blood-pressure should only be employed as a last resource in such cases and in small quantities, or the bleeding may become worse.

Where the bleeding has been effectively checked at its source by one or other of the methods just described the further measures depend on the severity of the bleeding. In minor degrees of collapse from bleeding little more is needed than the recumbent position with the foot of the bed raised, the body-warmth being maintained with warm bottles. Should, however, the general condition appear urgent, as shown by small or imperceptible pulse, great pallor, sighing, respiration, preparations should be made to increase the blood-pressure immediately the bleeding-point has been secured. Thus while the surgeon is exploring for a ruptured kidney an assistant may expose a vein in the arm and commence infusion of saline solution into this as soon as the renal vessels are secured. After the bleeding has been checked the following measures are available.

(*a*) The blood is made to flow from the extremities into the head by elevating the foot of the bed on chairs, or in the operating theatre by placing the patient in the Trendelenberg position. This is a simple, rapid, and efficacious plan. In addition the limbs may be bandaged over wool, which helps to empty these of blood while helping to keep the patient warm. In addition a firm binder may be applied round the abdomen, thus diminishing the amount of blood in the abdomen and forcing it into the cerebral tract.

(*b*) Oxygen may be administered by inhalation, and stimulating drugs such as ether and strychnine introduced hypodermically to tide over very urgent states of cardiac and vasomotor failure.

When the patient has survived the first onset of syncope the greatest reliance is to be placed in the infusion of saline solution to restore the bulk of circulating blood, which in cases of acute hæmorrhage is more important than its quality with regard to corpuscles and hæmoglobin.

A solution of common salt, one dram to the pint, gives a fluid sufficiently near normal for practical purposes; this should be sterilized and at a temperature of 105° F. ((in emergencies this may not be possible and good tap-water will be safe enough). Saline fluid may be introduced into the body in several ways. When the matter is very urgent and every moment is of importance injection into the veins is by far the most rapid method. In less urgent conditions the rectum is a serviceable place with good powers of absorption, or, if this be not available, from irritability and rejection of the proffered refreshment, or because the region has just undergone operative treatment, e.g. excision of the rectum or sigmoid, the fluid may be introduced under the skin of the axillæ, loins, or legs through fine needles. To assist in raising the blood-pressure adrenalin solution may be added to the saline fluid in the strength of a dram to the pint, but only when administered by rectum or intravenously, for if introduced subcutaneously the local vaso-constriction thus induced may terminate in wide-spreading gangrene. (See vol. i, p. 117.)

Fig. 1.   Infusion of saline solution into the median basilic vein.

METHODS OF INTRODUCING SALINE SOLUTION. (a) Intra-venous. Some thrust hollow needles of the size used for exploration direct into the vein without dividing the skin. This may be serviceable in some instances, but as a rule the veins of these ex-sanguine patients are small and not readily entered in this manner. In most cases it is better to expose the median-basilic vein at the bend of the elbow, pass a double ligature under the vessel, tie the lower one to act as a retractor, make a small longitudinal incision into the vein below the other ligature, introduce the blunt-pointed cannula, and tie the second ligature round vein and cannula. The fluid may be introduced with a tube and funnel attached to the cannula or with a syringe, the latter being more rapid; in either case care is taken not to introduce air-bubbles or air-embolism may result (with ordinary care this will not take place).

In urgent cases two to three pints may be introduced in five minutes for adults, after which the injection may be made more slowly up to five pints, which is about the limit for intravenous introduction. The vein is tied off after removal of the cannula, and the wound closed with a suture.

(b) For rectal or subcutaneous infusion the fluid passes in slowly and must be kept at a constant temperature. An inverted Thermos-flask forms a good receptacle, and the tube leading to the cannula or needle must be as short as possible to prevent cooling of the fluid in its passage through this. Where the subcutaneous method is used aspirating needles are introduced and the rate of flow of the fluid through these regulated by partial clamping of the tubes leading from the receptacle. The swelling of the limb from introduction of fluid should not be so great as to be painful, and fluid can be introduced at the rate of about one pint per hour. Ten pints are as much as it is wise to introduce, or œdema of the lung may result. When the patient is conscious and not inclined to vomit, plenty of fluid, such as weak tea or barley-water, may be given by mouth and is rapidly absorbed in this manner. After the acute stage has been passed through recovery will be rapid, especially in women, and is accelerated by generous diet and the administration of iron.

INTERMEDIATE OR REACTIONARY HÆMORRHAGE. This results from slipping of a ligature or giving way of clot in a vessel which has not been secured, and seldom occurs after twenty-four hours, since after that time the repair is tolerably firm ; in fact, after forty-eight hours pressure-forceps may be removed from such large vessels as the renal artery without risk of bleeding taking place, though no ligature has been used.

The condition is recognized by abundant oozing of blood through the dressings, and can generally be checked by re-dressing and firm bandaging with elevation of the part, but should the severity of the bleeding render it probable that a ligature has slipped from some large vessel the wound should be reopened and bleeding-points searched for and tied if found (which may not be easy). To assist in finding the bleeding vessels, clots are turned out and the wound douched with hot lotion. After securing all points the wound is closed with firm bandaging.

SECONDARY HÆMORRHAGE. This condition, once common and often disastrous, is now comparatively rare (thanks to the application of the Listerian method and its developments), since it is primarily always due to infection, which either prevents proper organization of the clot in the vessel or causes ulceration of the vessel-wall. Other causes which increase liability to secondary bleeding are : (1) High blood-pressure. (2) Inferior powers of healing, as in renal disease and diabetes. (3) Local diseases of the vessel-wall, such as atheroma or calcareous degeneration. (4) One of the most important causes is the presence of a foreign body which, assisted by infection, erodes the coats of the vessel, leading to perforation and hæmorrhage. Hence the rule that a drainage-tube should never be left in juxtaposition to a large vessel, and it is safer not to leave a tube close to such a vessel for more than two days lest, ulcerating through the intervening tissues, it ultimately rests against the vessel and destroys it.

Signs. The sudden appearance of bright blood on the dressings of an infected wound in the vicinity of a large vessel is suspicious, and this is seldom found for at least a week after the primary operation. In some

instances the escape of blood is profuse and may be rapidly fatal, but more
commonly it is slight at first, ceasing and recurring two or three times
before the final and fatal outburst takes place. Thus there is mostly ample
warning and time to take measures to deal with this serious condition.

Treatment. These cases need careful watching, and a tourniquet should
always be kept ready to apply at a moment's notice should a severe out-
burst of hæmorrhage take place. The wound should be opened at the first
signs of secondary hæmorrhage
and irrigated with hydrogen per-
oxide, all sloughs removed, and
search made for the bleeding-
point, which should be tied. If
no bleeding-point can be detected
the wound must be closed again
with efficient drainage and the
pressure of firm bandaging. This
will suffice when the hæmorrhage
is from small arteries, but where
the main vessel is involved the
ligature is almost sure to cut
through, and it will be safer to
tie the artery higher up through
a separate incision and pack the
wound firmly with gauze. Should
hæmorrhage recur, in all proba-
bility amputation higher up will
be requisite. Where a ligature
above the seat of hæmorrhage is
out of the question, as low down
in the neck, plugging with gauze
is the only resource.

Bleeding of a similar type to
secondary hæmorrhage may occur
as a primary condition when
vessels are eroded in the course
of disease, *e.g.* bleeding from

Fig. 2. A, Endarteritis. Infiltration and
fibrosis of the inner and middle coats of the
vessel. B, Thrombosis of a vein. The clot
is organizing and new capillaries are seen cut
in section.

gastric ulcers and in cellulitic and gangrenous conditions of the
extremities.

EMBOLISM AND THROMBOSIS

Since in many instances the general condition, *embolism*, depends on
local lesion of the vessels somewhere in the form of *thrombosis*, it may be
well to give a short account of the latter condition first.

THROMBOSIS. Allusion has been made already to the part played in the
healing of wounds of blood-vessels by thrombosis or clotting ; it is of import-
ance in other respects in the pathology of the vascular system. (Fig. 2.)

Thrombosis or clotting of the blood inside the vessels is normally pre-vented by the presence of the endothelial lining of the blood-vessels, and can only occur in the vessels when some alteration of their inner coat has taken place, whether of an inflammatory or degenerative nature, *e.g.* injury, atheroma, phlebitis. The coagulability of the blood is increased by other factors such as addition of calcium salts (in the absence of which blood will not clot) and excessive bleeding, which increases the coagulability.

In addition, a diminished rate of flow is supposed to be an adjuvant cause, but as blood remains fluid in an excised portion of jugular vein for at least twenty-four hours, this can hardly be a factor of much importance. The main cause of thrombosis is an alteration of the intima of the vessel where the process takes place.

VARIETIES OF CLOTS (thrombi). When stagnant blood clots rapidly in a vessel, *e.g.* the clot between a ligature and the next branch of a ligatured vessel, the thrombus is red and consists simply of ordinary coagulated blood, and at first can readily be separated from the vessel-wall just as can be done in the case of " post-mortem clots." Where, however, the thrombosis takes place slowly on the side of a vessel through which the blood is still flowing, more fibrin and leucocytes than red corpuscles are deposited, so that the clot is grey in appearance and on examination will prove to consist partly of organizing granulation-tissue and is firmly adherent to the wall of the vessel—being, in fact, the " ante-mortem " clot of pathologists. In surgical cases this variety is more often found in the walls of aneurysms, being then part of the natural process of cure by " obliteration." In some cases of this sort the clot is deposited with varying celerity, when rapidly as red, when more slowly as grey, coagulum, which on section gives the appearance of " laminated clot." In surgical practice thrombosis is chiefly found in veins, but also in the healing of aneurysms and in the obliteration of vessels after ligature.

FATE OF THROMBI. (*a*) The clot may become organized into fibrous tissue, obliterating more or less of the lumen of the vessel. Not infrequently there is calcification associated with this fibrosis, resulting in the formation of calcareous masses in the veins known as " phleboliths," which are common in the pelvis of middle-aged persons and may be mistaken for ureteric calculi ; they are also found in old-standing varicose veins of the leg.

(*b*) The formation of new capillaries in the process of organization of the clot may proceed to such an extent that the lumen of the thrombosed vessel is to some degree restored (canalization of the thrombus). In some instances the clot may be completely absorbed.

(*c*) Portions of the thrombus may break off and be carried off as emboli, passing in the circulation to distant parts, ultimately lodging in some narrow place, when embolism is said to occur, and, according to the character of the clot, these emboli may be simple or infective.

OTHER RESULTS OF THROMBOSIS. In addition to the local and embolic results of a thrombus there will be effects on the vessels both proximal and distal to the clot.

In the case of veins the proximal part of the vessel will be devoid of blood, and consequently collapsed, while the distal part will be turgid with blood, and if the vein be large there will be œdema of the part of the limb distal to the site of thrombosis. Later the anastomotic veins conveying the blood from the part will become enlarged. Thus in the case of blocking of the inferior vena cava the epigastric veins will become enormously increased in size, and the blood in these will flow up to the superior vena cava instead of down into the iliac veins. Should an artery become occluded the general arterial blood-pressure will be raised, possibly to a dangerous degree, while the anastomotic vessels will dilate to provide blood for the part supplied by the occluded vessel.

EMBOLISM. An embolus consists of free foreign or abnormal matter circulating in the blood- or lymph-stream of sufficient size to become fixed in the vessels at some part of the circulation, when the condition embolism is said to be present. Of emboli there are several varieties.

FIG. 3. Thrombosis of the axillary vein, showing œdema of the arm and dilatation of superficial veins.

(a) Derived from the blood or vessel-wall, such as detached thrombi, atheromatous plates, vegetations from diseased valves of the heart, and may be simple, *i.e.* non-infective, or infective, where pathogenic organisms are present in the embolus.

(b) Portions of new growths may become detached inside vessels, usually veins, and form emboli, lodging in the lung. Sarcomas are the form of neoplasm most commonly causing embolism in the blood circulation, while

cancerous emboli are frequent in the lymphatic system, passing along lymph-channels till they are arrested in some lymph-node, where they give rise to secondary deposits.

(c) Parasitic emboli (i.e. macroscopic parasites, the microscopic bacterial emboli are the result of infective thrombosis and embolism).

Thus a hydatid cyst of the liver may rupture into one of the large veins of the organ, its scolices passing into the circulation ; the immature filaria sanguinis hominis may pass as emboli along lymphatics, blocking the latter and giving rise to lymphatic œdema and elephantiasis of the scrotum and legs.

Emboli arising from injuries are of several varieties.

(d) Rarely some part of an organ may be detached and forced into a large vein ; thus after a severe crush of the liver a portion of this organ has been found in the right auricle, evidently having passed along the inferior vena cava.

(e) Air-embolism may result from openings made into veins, whether accidental or at operations. This is most likely to happen to the veins of the neck at their lower ends, as there is often a negative pressure during inspiration and air is easily drawn into the vein. Should any large quantity be sucked in, the right side of the heart will be filled with air and frothy blood, completely blocking the circulation and resulting in speedy death.

(f) Fat-embolism is a somewhat uncommon complication of fractures. A number of fat globules escape into the venous circulation from the cancellous tissue of the bone and, arriving in the lung, obstruct the circulation and cause pneumonic affection, or if in large quantities, death.

The consequences of embolism depend on the source and quality of the emboli.

(a) A large embolus originating in a vein, whether as a large piece of detached clot or a considerable volume of air, as in wounds of the vessels of the neck, will produce almost instant death from plugging the pulmonary artery or from filling this and the right side of the heart with froth, and thus instantly stopping the whole circulation.

(b) Small, simple emboli originating in veins will also pass into the lung, occluding some branch of the pulmonary artery. The area of lung supplied by the occluded vessel, which is of triangular shape, becomes filled with extravasated blood and quite solid, being known as a " red infarct." Such pulmonary embolism gives rise to local pain, cough and hæmoptysis, with signs of pulmonary consolidation when the infarct is superficial and of any considerable size.

(c) Simple emboli arising in the arterial circulation mostly come from the heart, being detached " vegetations " from the valves of the left side of the heart. Should such an embolus lodge in the main artery of a limb there will be sudden pain and loss of power in and anæmia of the part. This usually passes off fairly soon from dilatation of the collateral arteries of supply, though gangrene of distal parts may follow. Where, however, the circulation is " terminal," i.e. where anastomosis of the smaller vessels is but slight, as in the kidney or brain, the part supplied by the occluded

artery becomes an anæmic " white infarct," and undergoes aseptic necrosis, leaving a puckered scar. These infarcts are found most characteristically in the kidney, and the signs of pain in the loin and hæmaturia are noted in the early stages. Emboli in the spleen give rise to " red infarcts," causing the spleen to become enlarged, painful, and tender.

(d) Infective emboli give rise to secondary abscesses at the places of infarction ; thus infective emboli from bones (acute osteo-myelitis) or from the lateral sinus give rise to secondary abscess in the lungs. When a series of such infective emboli are being shot into the circulation the general condition is described as *pyæmia*, for though there is no pus actually present in the blood, yet the antecedents of the abscesses are borne along in the circulation.

AFFECTIONS OF THE BLOOD-VESSELS

CONGENITAL DEFECTS. In this section the hereditary disease hæmophilia alone will be considered, new growths of congenital origin being classed with other growths of blood-vessels.

HÆMOPHILIA. This is a curious, hereditary defect in which there is a tendency to bleed either spontaneously or as the result of injuries in a quite inordinate manner. The disposition is inherited, and in a striking manner, being only present in males but always inherited through female ancestors. Thus if a male " bleeder," as the subjects of hæmophilia are popularly termed, have offspring, neither the sons nor the daughters will inherit the tendency nor any of the descendants of the sons, but the male offspring of the daughters will often inherit the disease and transmit the taint to their descendants through their daughters. The hæmophilic tendency, which often passes off towards middle age should the patient survive, may be manifested as the result of injury, or the hæmorrhage may commence spontaneously, possibly as the result of some unnoticed trauma. When from surface wounds, possibly slight, *e.g.* drawing a tooth or even a pin-prick, the bleeding continues for days and weeks, rendering the patient very anæmic and at times proving fatal. The underlying cause is unknown ; there is no noticeable abnormality of the blood-vessels ; the blood clots slowly, but not sufficiently so to account for such prolonged bleeding.

Further, the tendency to prolonged bleeding varies in degree from time to time. Spontaneous bleeding may take place into cellular tissues, under the periosteum into joints, or from mucous surfaces.

The former conditions resemble acute inflammations, cellulitis, periostitis and arthritis, but the absence of fever and severe constitutional disturbance will prevent the surgeon from falling into the serious error of opening these swellings. The family and personal history may be of assistance in the diagnosis from scurvy and purpura (*see also* Joints).

Treatment is chiefly preventive and directed to avoiding injuries, and above all to avoid operations. While bleeding is proceeding, firm bandaging and the local application of adrenalin is advised, while administration of calcium lactate to increase the coagulability of the blood may be of service.

Cases are reported where bleeding has ceased after injection under the skin, or per rectum of large quantities of the serum of horses and other animals, and in severe cases this is worth repeating, although the result is not certain.

INJURIES OF BLOOD-VESSELS

Arteries and veins alone will be considered ; injuries of capillaries have been sufficiently described under Hæmorrhage.

ARTERIES. The following varieties are described : (1) Subcutaneous, which may be contusions or ruptures ; (2) open wounds, which may be incised, lacerated, punctured, complete or incomplete, including gunshot injuries.

(1) Subcutaneous lesions of arteries.

(a) Contusions, if of sufficient violence to produce alterations of the inner coat of the vessel, may lead to thrombosis and obliteration at the site of lesion. This is more likely to happen where the artery is the seat of atheroma or other disease.

(b) Subcutaneous rupture may be :

(1) *Incomplete*, in which case the inner and middle coats give way most readily and by their contraction and retraction block the lumen to a great extent ; thrombosis will follow the injured point, and as this becomes organized the vessel may become obliterated. In other instances, especially where the lesion only affects part of the circumference of the vessel, the injured part gives way under the arterial pressure and the wall bulges at this point. The bulge gradually increases and is known as an *aneurysm*. Less often the blood is forced between the middle and outer coats at the site of lesion and separates these for some considerable distance, the condition being then known as a "dissecting aneurysm."

Signs. Where the result is obliteration of the vessel this occurs gradually and the collateral circulation has time to increase ; consequently there is but little risk of gangrene taking place, but the pulse will become weak below the site of injury and there may be some weakness of the limb. The signs of aneurysm are discussed later.

Treatment. Where there are signs of obstruction of the vessel the limb is raised and kept warm to maintain the circulation in the periphery. But should the circulation be much impaired and there be some prospect of gangrene occurring, or should an aneurysm develop, the injured vessel should be explored and treated as described under Open Injuries and Aneurysms—by suture, ligature, &c.

(2) *Complete Subcutaneous Rupture of Arteries.* In some instances the retraction and curling of the intima will seal off the vessel and little blood be effused, the only signs being loss of pulsation in the vessel. More commonly there is a large and rapid escape of blood, forming a swiftly increasing swelling, pressing severely on surrounding structures. Examples of this condition are ruptures of the popliteal artery associated with fractures and separation of the epiphysis of the lower end of the femur or of the middle meningeal artery, with the resulting rise of intracranial pressure, causing

compression of the brain. This condition is sometimes known as diffuse traumatic aneurysm, which is not a very good term as there is no aneurysmal sac.

Signs. At the time of injury a sharp pain and the sensation of " something snapping " is often noted by the patient, and in a few minutes a swelling appears at the site of the injury, which later causes œdema and discoloration of the skin and in which pulsation may be detected, while if digital pressure be made on the main artery above the swelling the latter will cease to increase but cannot be emptied as can an ordinary aneurysm. The limb below becomes pulseless and blanched at first, but later œdematous and cyanosed from pressure on the large veins. Still later signs of gangrene will develop, while where the rupture is inside the skull signs of cerebral compression will develop. The course varies. In some instances clotting around the rupture will obstruct the vessel and the condition gradually subside as collateral circulation is established. More often either the skin over the effused blood will ulcerate through and the latter burst on the surface or suppuration take place in the large hæmatoma, also ulcera-

Fig. 4. Traumatic aneurysm of the brachial artery.

ting through the skin and leading to violent external bleeding, or gangrene below the obstruction in the vessel will set in.

Treatment. Seeing the danger which may arise if expectant measures be prolonged and that, owing to the matting of tissues by clot, the operation becomes more difficult the longer it is delayed, it will be safest to explore the injured vessel in all cases where there is much swelling and the diagnosis is tolerably sure (this applies to main vessels, *e.g.* the popliteal). Where it is uncertain, in cases of possible injury to smaller vessels or veins, delay is allowable. The operative treatment consists in placing a tourniquet above the seat of rupture or a temporary clamp on the main artery above and opening the swelling freely, and searching for the opening in or rupture of the artery. When this is found it may be sutured or the artery divided between two ligatures at this point. Where both artery and vein are ruptured one of these at least should be restored by suture, or gangrene is almost certain.

(2) *Open Wounds of Arteries.* These again may be divided into lacerated and incised, partial and complete.

(a) *Laceration of Arteries in Open Wounds.* These occur in avulsion of limbs by machinery, severe " crush accidents," explosions, and shell-

wounds. The torn ends of the vessel, being crushed and lacerated, usually retract freely, and in most instances hæmorrhage is slight even where such large vessels as the popliteal are torn.

The treatment is as for lacerated wounds in general, but in addition, should such a wound traverse the situation of a large artery the latter should be examined, and if found torn, even if not bleeding, should be tied above and below the site of injury unless there are special reasons for attempting to suture the vessel or to insert a graft.

(b) *Incised Wounds of Arteries.* These may be complete or incomplete division or punctures penetrating the lumen of the vessel, or wounds, traversing part of the wall of the vessel.

In the latter instance the wall will give way gradually, and later a traumatic aneurysm will arise. There are no signs especially pointing to this condition, but it may be discovered in exploring a wound, and the vessel thus injured should either be divided between ligatures at the injured spot or, better, in large vessels, the injured part excised and end-to-end anastomosis performed.

Where the wall of the vessel has been penetrated profuse bleeding will generally ensue except in the case of small vessels completely divided, when retraction may seal off the vessel and prevent hæmorrhage.

The bleeding may be external where the wound is freely open, but if of the punctured variety, as from stabs, impalement, or bullet-wounds, the blood may not escape readily on the surface but collect around the vessel in the depths, as in the case of subcutaneous rupture of a vessel (diffuse traumatic aneurysm).

FIG. 5. Treatment of a traumatic or false aneurysm by suture of the wounded artery.

Signs. Where escaping freely the scarlet, intermittent jet of blood will render the nature of the injury clear, but in the depth of a punctured wound the rapidly increasing swelling and possibly pulsation will point to the necessity of early exploration.

Treatment. The wound should be enlarged if necessary to permit thorough exploration (a tourniquet should be first applied above the injury). When the injured point is discovered the vessel is usually divided between two ligatures or sutured if large, and there is a prospect of gangrene following on ligature. It should be noted that in the case of a wound which is bleeding freely and likely to involve a large vessel the surgeon should explore the wound and never cut down on the main artery and tie this in the first instance, assuming it to have been injured, as in many instances of this sort tying the main vessel will not control the bleeding, which comes from some branch above the site of ligature on the main trunk. Ligature of the main vessel is only to be employed where the surgeon fails to find the bleeding-point and plugging fails to control the hæmorrhage.

To sum up : All cases of penetrating wounds of large arteries should be explored whether bleeding persists or not (in the case of deep punctured wounds, where the patient is collapsed, exploration may be put off a few hours till the patient is in better condition, hæmorrhage being controlled with a tourniquet). If the artery be ligatured both ends should always be tied above and below the wound, as severe bleeding readily takes place from the distal end of the divided vessel owing to the freedom of the collateral circulation. Finally, the exploratory attack should always be made on the injured vessel and never primarily on the main artery of the limb.

Injuries of Veins. These may be subcutaneous or open.

(1) Subcutaneous injuries may complicate fractures and dislocations or efforts to reduce these injuries. Owing to the slight retractile property of veins, bleeding is likely to continue for some time, but on account of the low pressure in these vessels the effusion will increase but slowly.

The signs somewhat resemble those of subcutaneous rupture of an artery, but the swelling appears more slowly, taking hours where in the case of an artery it will take minutes ; nor is the pulse in the limb below affected for a considerable time. Œdema and swelling of the limb will arise later, and possibly suppuration in the effused hæmatoma, but the obstruction to the circulation is not likely to be so severe as to lead to gangrene.

Treatment. The further effusion of blood can be checked by firm pressure of a bandage over wool applied to the site of injury, and if the rupture be in the smaller veins of a limb the latter should be kept elevated and warm till circulation is satisfactorily restored. Should, however, the rupture take place where pressure cannot be applied or where this is insufficient to control further bleeding, *e.g.* in the case of venous sinuses of the skull, the site of injury should be explored and the vein tied above and below the rupture or sutured so as to restore its lumen.

(2) *Open Wounds of Veins.* Whether lacerated, punctured or incised, these present the characters of venous bleeding which is profuse but readily controlled by pressure. Such wounds may be accidental or of surgical origin, in the latter case especially of the jugular, axillary and femoral, when they are usually incomplete or punctured.

Treatment. Elevation and the pressure of bandaging will check hæmorrhage from small veins of limbs. Should a main vein be punctured, the wound is explored and the aperture should be secured with a fine silk ligature, which applied laterally will only obstruct part of the lumen of the vessel ; where the vessel is completely divided the two ends may as a rule be tied, but where the arterial supply is not good an attempt should be made to restore the continuity of the vessel by suturing with fine silk soaked in sterile vaseline.

Air-Embolism in Veins. This is an even more urgent condition than hæmorrhage and is caused by the pumping action of the thorax, which during inspiration forms a negative pressure inside the veins, especially at the root of the neck (jugular and subclavian). Should such a vein be cut

or punctured, air may be sucked into the vessel, and if in any quantity may lead to pulmonary embolism, as already mentioned. The accident most usually takes place in operations deep in the neck, as for removing glands around the jugular vein, and is recognized at once by the " hiss " as the air rushes into the vein. If the aperture be occluded at once, usually no ill-effects arise, but if the warning hiss be neglected the patient may pass rapidly into a most precarious condition. The pulse becomes small, the skin blanched, and respiration laboured ; the pupils dilate, and death occurs in a few seconds. Sometimes a patient may recover from an attack of this sort and the heart resume its functions again.

Treatment. This untoward complication can generally be prevented by careful operating and by clamping veins before dividing them. Should this accident occur treatment should be prompt. It is sometimes advised to flood the wound with saline solution, but this takes time and renders the finding of the aperture a less easy matter ; far quicker is it to place a finger on the aperture and work it slightly along the vein towards the heart to prevent further entry of air, and then secure the aperture in the vein with catch-forceps and effectively occlude with a fine silk ligature. A small amount of air may be aspirated into veins without ill-effect, but this must not make the surgeon careless and treat the warning " hiss " with sluggish indifference, for such patients have at times perished rapidly, from failure to recognize the urgent necessity for instant occlusion of the injured vein. Where severe symptoms follow this accident the patient should be inverted and oxygen administered (after occluding the vein with forceps), and if this fails to improve matters the right ventricle of the heart should be tapped through the fourth costal space, one inch from the edge of the sternum, with an aspirating syringe and the mass of froth and air extracted from the right side of the heart.

Clot-Embolism, following Injuries to Veins. The clots forming after injuries to veins may become detached, and such a separation of thrombus is of more importance than in the case of most arteries except of the carotid, where the embolus may pass into the brain. In the case of veins the embolus will naturally pass into the lung *via* the right side of the heart, producing effects dependent on its size—instant death if very large, or hæmorrhagic " red infarcts " followed by pneumonic conditions, which in turn may prove fatal if of large extent. Further, should such clots have become infective, the process of embolism of the lung will lead to pulmonary abscess.

Injuries of Arteries and Veins together (aneurysmal varix, varicose aneurysm, arterio-venous anastomosis). These accidents are less common than in the days when bleeding was the panacea for all ills and the busy apothecary shot his lancet through the median basilic vein into the brachial artery lying underneath. They, however, are still found as results of stab-wounds and gunshot injuries, especially with high-velocity, small-bore weapons, between the carotid artery and jugular vein, between the femoral artery and vein in the interesting condition of pulsating exophthalmos,

and anywhere that an artery and vein lie close together. After such injuries, when healed, a communication exists between the artery and vein. There are two varieties of such arterio-venous communication :

(1) *Aneurysmal Varix.* In this condition the vessels are in immediate communication ; the vein dilates and tends to become varicose under the unaccustomed internal pressure.

(2) *Varicose Aneurysm.* In this case there is a sac between the artery and vein communicating with both these vessels by a separate aperture. In rare instances these conditions may be due to disease.

Signs. An aneurysmal varix presents at first sight the characters of a varicose vein, but on further investigation the vein will be found tense and pulsating, and on auscultation a buzzing bruit will be heard, which has been likened to the sound made by a fly enclosed in a paper bag. There may also be venous engorgement and œdema of the part drained by the vein distal to the varix, especially when this is inside the cranium.

In the varicose aneurysm, in addition to the presence of an aneurysmal sac with the usual character and soft bruit (*see* Aneurysm), there will be dilatation and pulsation of the vein.

Fig. 6.

Aneurysmal varix.   Varicose aneurysm.
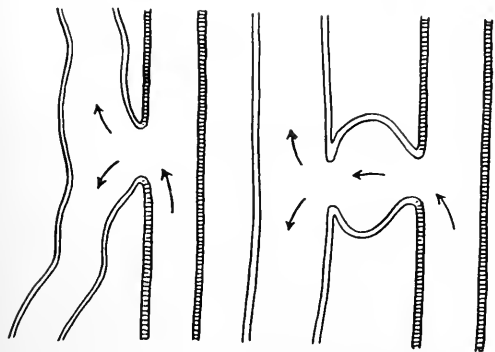
Treatment. Aneurysmal varix has little tendency to become enlarged or burst, and can often be sufficiently controlled with an elastic bandage. Should, however, the varix be increasing rapidly or causing pressure-trouble the site of injury should be explored, and as a rule the artery tied above and below the opening into the vein, though in a few instances it may be feasible to repair the walls of both artery and vein by suture. In the intracranial variety operative measures are generally indicated owing to the worry caused by the incessant noise in the head and the danger to the eye from exophthalmos and pressure on the optic nerve. In these cases the operation consists in tying that common carotid which when compressed causes the pulsation to cease (this is not always the artery on the side of the exophthalmos)—see Orbital Aneurysm.

Varicose aneurysms, like ordinary aneurysms, have more tendency to progressive enlargement, ending in ulceration, bursting, or gangrene of parts distal to the affection ; hence operation will generally be indicated. The aneurysm is explored and the artery tied above and below the sac, and the latter excised or allowed to contract : the vein should be left intact if possible. Suturing operations to restore both vessels may sometimes be possible.

INFLAMMATIONS AND DEGENERATIONS OF ARTERIES. These are of importance in surgery in three ways. They may weaken the vessel-wall

so that it gives way under the intra-arterial pressure, resulting in bursting or formation of aneurysms. The calibre of the vessel may become so narrowed as to cause malnutrition, necrosis, and eventually gangrene of the tissues or limb supplied by the vessel. Thirdly, such vessels become brittle and unfavourable for ligature or other operations.

INFLAMMATIONS. Several varieties may be mentioned :

(1) *Plastic and Reparative Arthritis.* This is the process of repair by formation of fibrous from granulation-tissue, resulting after laceration, bruising, incision, ligature, &c., and ends in the replacement of part or all of the circumference of the vessel with fibrous tissue, which may withstand the intra-arterial pressure or dilate, giving rise to an aneurysm.

(2) *Acute Infective Arthritis.* This may result (*a*) from spread of infection in the tissues around the vessel, causing ulceration of the latter and

FIG. 7. A, Endarteritis of the circular type with excessive formation of fibrous tissue in the inner coats of the vessel, tending to lead to its obliteration. B, Nodular endarteritis (atheroma) or delocalized degeneration of the inner coat.

softening of its coats till the wall gives way, resulting in secondary hæmorrhage. This may occur in any infected and ulcerating region, but especially where in such a focus of infection there is a drainage-tube or other foreign body impinging on the artery.

(*b*) From inside the vessel, following the lodgment of infective emboli. Should the infection be of severe type embolic abscesses will develop (pyæmia), but in cases of milder infection the arterial coats soften and give way, leading to formation of aneurysms, which in young persons is not uncommon, associated with and due to cardiac vegetations and resulting in arterial embolism of the systemic circulation should these become detached.

(3) *Syphilitic Arthritis.* In this disease there is a chronic hyperplasia of the intima of the smaller vessels, which may assume such a degree that the vessel becomes obliterated. This is one form of " endarteritis obliterans," and accounts for the sloughing of gummas from the anæmic necrosis thus produced. In the larger vessels the media is also affected by chronic inflammatory changes, and the wall, becoming soft, yields to the bloodpressure, with formation of aneurysms (Fig. 7 A).

(4) Tuberculous endarteritis of very similar nature to the last-mentioned type is found in the small vessels around tuberculous lesions.

Changes which are to be regarded rather as degenerations.

(5) Atheroma commences as a chronic inflammatory or degenerative softening of the media of the larger vessels, which becomes weakened, while the corresponding intima is thickened by the formation of fibrous tissue, which readily undergoes fatty and calcareous degeneration, forming nodes or plaques on the interior of the affected vessel. These areas of degeneration soon break down into the lumen of the vessels as atheromatous abscesses and ulcers. Portions of the debris may be carried away in the blood-stream as emboli, while the wall is much weakened and may give way, leading to aneurysm. The underlying causes of this disease are middle-age, renal disease, alcohol, and irregular violent exertion (Fig. 7 B).

(6) Calcareous degeneration affects the middle coats of the arteries of the aged, especially those of medium calibre such as the brachial and popliteal. The walls of such vessels become rigid like pipe-stems, while the lumen is narrowed so that the blood-flow to the extremities is much impaired. This affection is an important factor in the production of senile gangrene. Aneurysms are not usual in these cases, but these vessels are brittle and easily ruptured by trauma, while owing to their friability they are very inconvenient to secure with ligatures.

ARTERIO-SCLEROSIS. This term is applied to the last three conditions, syphilis, atheroma and senile calcification of vessels, as well as possibly other conditions which increase the resistance in the periphery of the circulation and so raise the blood-pressure. The latter side of the question is considered in works on internal medicine. The surgical interest of these affections turns chiefly on the resulting aneurysm, embolism, or peripheral gangrene.

ANEURYSM

An aneurysm is a sac or cyst containing blood or blood-clots, which may be more or less organized, communicating with an artery and partly or wholly formed of the distended wall of the latter. This definition excludes the condition sometimes described as diffuse traumatic aneurysm or subcutaneous rupture of an artery, since in that case the vessel is not dilated and there is no proper sac (Fig. 8).

Causes. (1) Aneurysms may arise in perfectly healthy arteries from injuries, such as laceration, involving part or the whole thickness of the wall and punctures or cuts into the lumen, where only part of the circumference of the vessel is divided.

(2) The affection may arise quite apart from injuries, owing to deficient resilience of the wall together with increase of blood-pressure, both of which conditions are associated with arterio-sclerosis of the varieties described above, whether syphilitic, atheromatous or tuberculous, and depending on gout, renal disease, chronic lead-poisoning, over-exertion, especially if of a spasmodic nature. Of all these causes syphilis is at present regarded as the most important.

(3) Injury and arterial disease may both be responsible; thus the

tendency for aneurysms to occur at certain places, *e.g.* in the popliteal space, may be explained in this way. Minor injuries may affect the vessel and determine the place where a weakened vessel in the presence of high arterial tension will give way and bulge.

Structure. The sac of an aneurysm consists in some instances entirely of the distended wall of the artery, but more usually, after developing to some size or from the outset in a case due to local injury, the intima and media form only part of the sac—the rest of the sac, which may be the greater portion, consisting of the fibrous tissue surrounding the vessel, including the adventitia, much condensed by pressure. Where the lining of the sac is of normal endothelium the blood remains fluid, but where the inside of the sac consists of fibrous tissue or the endothelium has undergone alteration the blood clots on the inner surface of the sac, being laid down in layers so that on section the clot has a laminated appearance. The part of the clot next the sac becomes organised and firmly adherent to the latter, while the part next the fluid blood inside the sac more closely resembles ordinary fresh blood-clot. This deposit of clot and its organization is the natural method of cure, the organizing clot gradually filling the sac, while the arterial pressure is constantly distending it and making it larger. The ultimate result depends on which process

FIG. 8. Diffuse traumatic aneurysm.

is the more effective ; if clot is deposited and organized till the sac becomes converted into a mass of fibrous tissue the artery is obliterated at this point and the aneurysm is cured. More usually the process of distension is the more rapid of the two, and the sac ultimately gives way or undergoes other changes as described later.
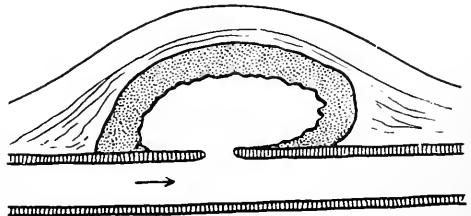
VARIETIES OF ANEURYSM. As regards form three varieties are described, the fusiform, saccular, and dissecting.

(1) A *fusiform* aneurysm consists of a uniform dilatation of the whole circumference of the vessel, so that the latter becomes a swelling, of spindle shape, consisting of all coats of the vessel. This type is hardly known in surgical practice, being usually confined to the thoracic aorta, and the dilatation is but slowly progressive, though after a while some part of the wall generally gives way more rapidly than the remainder, so that the aneurysm assumes the saccular form. This type is always due to disease and never to injury (Fig. 9 A).

(2) The *saccular* variety may be the result of injury or local disease ; the inner and middle coats are mostly destroyed at the part where the main distension is present, and consist of an asymmetrical bulging of the artery on one aspect ; commonly, however, there is a general dilatation of the rest of the circumference of the vessel at this point (Fig. 9 B).

(3) A *dissecting* aneurysm is a rare type occurring in the aorta, the blood having forced its way between the coats through some atheromatous erosion, and usually splits the media, forming thus a tunnel which may extend some distance in the wall of the vessel. This form demands no further consideration in a work on surgery (Fig. 9 D). Aneurysms are further distinguished by their position into internal, or those inside the thorax, and external, or those of the limbs and abdomen.

When the sac of an aneurysm gives way slowly and blood is being extravasated the condition is described as a leaking or diffuse aneurysm.

CONSEQUENCES AND TERMINATIONS OF ANEURYSMS. Aneurysms have the same local effects as other slowly growing tumours, causing pressure on and paralysis of nerves (*e.g.* the recurrent laryngeal in aortic cases), pressure on veins, causing œdema of peripheral parts ; pressure on bones, causing rarefaction and erosion ; pressure on the skin, leading to ulceration.

Terminations. (1) Healing may take place as mentioned, by a deposit of laminated and organizing clot gradually filling the cavity of the sac, or occasionally by sudden clotting in the sac, following a block of the outlet to the latter by a piece of clot detached from its interior.

(2) Giving way, leaking, and bursting of the sac may be due to injury or simple over-distension, the wall becoming thinned

FIG. 9. A, Fusiform aneurysm. B, Saccular aneurysm. C, Fusiform and saccular aneurysm. D, Dissecting aneurysm.

more rapidly than it is thickened by deposit of clot. The wall may give way slowly and the sac leak or burst suddenly with profuse and often fatal hæmorrhage.

(a) Leaking is the more usual manner of giving way in the aneurysms of the limbs. The tumour increases more rapidly in size and becomes less well defined, while the pulsation is less noticeable. Pressure on veins and nerves leads to rapidly increasing œdema and paralysis ; while suppuration in the extravasated blood, ulceration of the skin, or gangrene of the extremity below may follow.

(b) Sudden bursting is more usual in the case of internal aneurysms and mostly takes place into some body cavity or tube, when there will be sudden and fatal hæmorrhage from the trachea, œsophagus, &c. Where the aneurysm is in an artery of an extremity the bursting will usually be subcutaneous. The sac suddenly becomes larger and diffuse and, the circulation below ceasing, the pulse is obliterated, the limb blanched and

cold, while signs of gangrene rapidly ensue. Should the sac be near the surface it may burst through the skin with profuse hæmorrhage.

(3) *Inflammation and Suppuration.* As has been mentioned, aseptic inflammation of moderate degree will increase the rapidity of clotting and organization, tending towards cure. Suppuration from surgical interference is not common in these days, though in the times before ligatures were aseptic such misfortunes were common. More usually suppuration is the result of auto-infection, and generally when leaking has already commenced. There are the usual signs of inflammation, heat, redness, œdema of the skin, and fever. Such an abscess points sooner or later and bursts, discharging blood and pus, the hæmorrhage being likely to terminate fatally unless surgical assistance is swiftly available.

SIGNS OF ANEURYSM. These apply to the external varieties : those occurring in the thorax are mentioned briefly in the section on Special Aneurysms, and for a full account the reader is referred to works on internal medicine.

(a) While in the growing stage an aneurysm will be found as a tumour possessing an intermittent, expansile impulse synchronous with the pulse. Pressure on the main artery on the proximal side of the tumour will cause the pulsation in the aneurysm to cease, the sac meanwhile becoming less tense and capable of being emptied by steady pressure to a varying degree (dependent on the amount of clot present). On relaxing the pressure from the main vessel proximal to the sac, the tumour will become filled again and tense in two or three beats of the heart. A blowing bruit, systolic in time, can be heard over the tumour with stethoscope. The pulsation can be seen readily with the eye if superficial, and if deep-seated with the fluoroscopic screen. Both pulsation and bruit are much less in evidence where the aneurysm is consolidating from organization of internal clot, and are absent when the sac is quite solid. In addition to the signs in the tumour itself the results of pressure may be marked on veins, nerves, bone and skin, causing œdema, paralysis, erosion of bone (cartilage is but little affected), and ulceration of the skin. The results on the circulatory system are hypertrophy of the heart in case of aneurysms of the larger trunks and peripheral embolism from detachment of clot inside the sac, which more usually affect the brain, kidneys, and spleen than the limbs. The pulse beyond the sac is delayed in point of time beyond that on the normal side and is also lessened in volume.

(b) When healing spontaneously the sac becomes smaller and harder, while pulsation and pressure signs are less marked, till finally pulsation disappears.

(c) When leaking the tumour becomes rapidly larger but less distinct ; the pulsation is less marked and pressure signs increase rapidly.

(d) When the sac bursts into a closed cavity such as the pleura or peritoneum, signs of internal hæmorrhage develop rapidly. When the sac gives way into a cavity communicating with the outer world (stomach, gut, trachea, œsophagus) there will be sudden syncope and profuse bleeding

from the appropriate orifice. Where the rupture is subcutaneous the tumour rapidly increases, losing its shape ; there is loss of pulsation and blanching of the limb below, shortly followed by paralysis, œdema, and gangrene.

Diagnosis. (1) From a fluctuating tumour, abscess, or cyst which either lies over the artery and is pushed up by the latter or itself pushes up the artery.

The impulse in the case of tumours other than aneurysm is not expansile. If the fingers are placed on two opposite points of the circumference of the swelling they are not separated with each pulsation, as is the case when the swelling is aneurysmal. An apparent exception to this may occur when a tumour lies over an artery and is pushed up by the latter, since if a diameter less than the greatest lies between the fingers when the mass is pushed up by the pulse-beat a larger diameter will be pushed between the fingers and give a feeling suggesting expansion. Care must be taken, then, to estimate expansile impulse in the greatest diameter of the swelling and in more than one diameter. In addition, such tumours, though ceasing to pulsate when the main artery above is occluded, do not become smaller or less tense, nor can they be emptied.

(2) Highly vascular tumours such as sarcomas of bone and some goitres have also an expansile impulse, but the expansion is less in amount and power, and these tumours are little diminished in size by compression of the main artery proximal to the tumour and cannot be emptied ; further, they often occur in a situation out of the course of any main artery.

(3) A normal artery pulsating excessively, as is often the case with the abdominal aorta in women, should not be mistaken for aneurysm as there is no dilatation of the vessel.

(4) An obsolete healed aneurysm can hardly be distinguished from other solid tumours apart from the position, history, and previous observations.

(5) In the early stages where the aneurysm is deep and little or no swelling can be detected, it may readily be mistaken for neuralgia, spinal caries, rheumatism, &c. (especially in aortic cases). The X-ray will sometimes afford valuable information long before other physical signs are present.

Prognosis. Natural cure by organization of clot gradually or suddenly formed in the sac accounts for a small percentage of cures, but the general tendency is to progressive enlargement and final bursting, &c. Under treatment advance may be greatly delayed and cure attained in favourable cases, especially of the external varieties, where surgical measures can be employed.

Treatment. The main lines of treatment are as follows :

(1) Following Nature's lead, to increase the formation of clot in the sac and the organization of this. Both general and local measures or a combination of these may be employed.

(2) To remove the aneurysm—a method only suitable for aneurysms of smaller vessels.

(3) To obliterate the sac by operative measures, if possible restoring the lumen of the artery, but more usually obliterating this with the sac.

(4) *Amputation.*

(1) Methods which aim at increasing the rapidity of clotting and fibrosis in the sac-wall are of the following varieties :

(a) General methods to diminish the blood-pressure and increase the coagulability of the blood.

(b) Diminishing the blood-flow through the sac by temporary or permanent, complete or partial, occlusion of the artery proximal or distal to the sac.

(c) Increasing clotting and fibrosis in the sac by local measures.

These methods may be employed together.

(a) *General Measures.* The blood-pressure is lowered by restricting the food and drink to the barest minimum and keeping the bowels freely opened (Tufnell's starvation method). The blood-pressure may be further lowered by free administration of iodides, and the coagulability of the blood increased by giving calcium lactate internally. In addition the recumbent position and absolute rest assist in lowering blood-pressure and are essential. Injections of a solution of gelatin have been employed to increase the coagulability of the blood, but with little result. This line of treatment is suitable for cases where local interference is out of the question or can only be of an incomplete nature, as in the thorax or upper abdomen. When carried out fully this plan is infinitely tedious and tiresome for the patient, but in a modified form a moderately low diet with recumbency and administration of iodides and calcium salts may prove a useful adjuvant to local measures directed to produce clotting in the sac.

(b) Local measures to diminish the flow of blood through the sac.

(1) This has been managed by external manœuvres, compressing the main artery above or below the sac. Prolonged digital pressure (by relays of dressers, fortified for the struggle with much beer) continued for twenty-four hours, tourniquets and bandaging the limb in a flexed position were formerly in vogue, but with the advance in asepsis have become practically obsolete. For, although successful in some instances, these methods were not without danger from gangrene, bursting of the sac (where the vessel was occluded below the aneurysm) ; moreover, the collateral circulation was opened to such an extent that ligature afterwards was useless, besides being extraordinarily painful and tormenting to the patient, so that these plans are now of little but historic interest.

(2) *Ligature of the Main Vessel or its Branches.* The ligature is applied either proximally or distal to the sac in its immediate vicinity, or proximally at a distance. The following plans have been used (Fig. 10) :

(a) Anel's method consists in ligature immediately proximal to the sac.

(b) Brasdor tied the main vessel immediately distal to the sac.

(c) Wardrop tied one or more branches of the vessel immediately distal to the sac.

The latter method appears at first sight rather inefficient compared with those preceding, but in fact no single ligature, whether proximal or distal,

completely stays the flow of blood through the sac but, owing to the various lateral branches of the sac, simply diminishes the flow. The objection to all these operations close to the sac is the matting of tissues and difficulty in dissection in its vicinity, and in former days the added sepsis increased the difficulties and the probability of the dreaded secondary hæmorrhage. These points led Hunter to devise his operation of proximal ligature at a distance. In recent aseptic times operations close to the sac have been more successful.

(d) Hunter's method consists in tying the main artery some distance above the aneurysm, e.g. the femoral artery in Hunter's canal for a popliteal
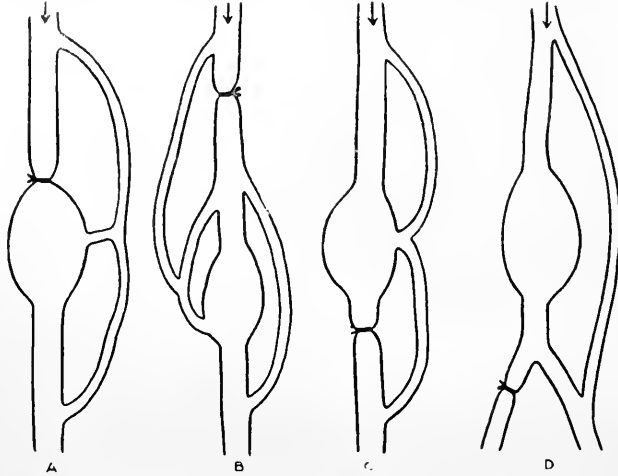
FIG. 10. Methods of applying the ligature in the treatment of aneurysm. A, Proximal ligature (Anel). B, Proximal ligature at a distance (Hunter). C, Complete distal ligature (Brasdor). D, Distal ligature of branches (Wardrop).

aneurysm. The main advantage is that it is considerably easier to tie the vessel where normal at a distance than close to the aneurysm, and this was far more important before anæsthesia and asepsis were known. The disadvantages of this method are obvious. If the operation is successful the artery is blocked at two places, viz. the sac and the point of ligature, so that there is considerable danger of gangrene of the extremity, which may only affect a few toes or necessitate amputation of the foot. Again, the collateral circulation to the sac is better, and there is some chance that the flow through the latter will not be sufficiently diminished to cause clotting. Thus, in spite of the great name attached, this method is passing into oblivion.

(c) Local operations on the sac to increase clotting and fibrosis.

(I) Acupuncture (Macewen) consists in passing long but fine needles into the interior of the sac and systematically causing a scratching of the opposite wall by the pulsation of the sac. The needles are left in for some hours and their position shifted from time to time so as to finally include a large area of the sac. Clotting and organization take place on the irritated

surface and the sac gradually fills and solidifies. This method is suitable for internal aneurysms where ligature is inapplicable, and some good results are reported.

(II) The sac may be filled with yards of fine wire introduced through a cannula (Moore) or folded into a sort of cage which expands after being introduced by means of a special pistol-like weapon (Colt and Power).

(III) Electrolysis by means of needles or through a long wire introduced through an insulating cannula (Conradi), after which the wire is pushed completely in the sac so as to get the effect of a foreign body as well as of electrolysis. Good results have attended some of these attempts, but there is more chance of a fistula resulting (ending in fatal secondary hæmorrhage) where a cannula is introduced than where the finer acupuncture needles are used, especially if the current be over-strong and any cauterization of tissues takes place.

(2) Excision of the aneurysm is excellent where possible, but often out of the question owing to the matting of tissues around and the involvement of veins and nerves, with risk of paralysis or gangrene following damage to these. After placing a tourniquet above the aneurysm this may be dissected out unopened or opened, the clots turned out, and the wall dissected from its surroundings. Should, however, there be difficulty in doing this, it will be best to secure all the vessels entering the sac and invaginate the latter by sutures as in Matas's operation.

(3) Obliteration of the sac by opening it and tying or suturing the feeding vessels, with or without restoration of the lumen of the vessel.

(a) *The Old Operation* (Antyllus) consisted in making a small hole into the sac and inserting a finger inside and feeling for the openings of the feeding arteries ; securing these by digital pressure, the sac was swiftly laid open, clots turned out, and the vessels secured as they entered the sac. The operation concluded by packing the sac and leaving it to granulate, or dissecting out the sac, when the operation conformed to the modern operation of excision of the sac. The operation as thus performed is very difficult and uncertain as to its outcome, for there are almost certainly not only two openings into the sac, one at each end, but also lateral openings, which may be missed and fatal bleeding ensue before these are sutured. Hence the mortality was high. If performed in more peripheral vessels with the help of a tourniquet or temporary proximal clamping of the main vessel,· the operation becomes more easy and is practically the same as that next described.

(b) *The New Operation* (Matas). This method has been practised in two forms, the *obliterative* and *restorative*, and suggested in a third, the *reconstructive*.

(1) *The Obliterative Operation* (Matas). This is really the modern development of the old operation. The limb is rendered avascular by means of the tourniquet, the sac laid open and clots turned out, when, instead of dissecting the sac out (excision) or leaving it to granulate (old operation), the openings of the feeding arteries are all carefully occluded by suturing

with catgut from inside the sac and the latter folded up by means of mattress sutures and thus brought over and made to reinforce the suturing of the openings into the sac. In this manner the sac, and consequently the artery, at this point are firmly obliterated. The advantages of this method are that the sac is obliterated with precision and not left to possible clotting inside as in the various plans in which the ligature is used ; further, the sac ceases to exist as a large tumour pressing on surrounding structure and likely to cause gangrene and paralysis ; it is superior to Hunter's method in that the artery is only obliterated at one point, and to excision in so far
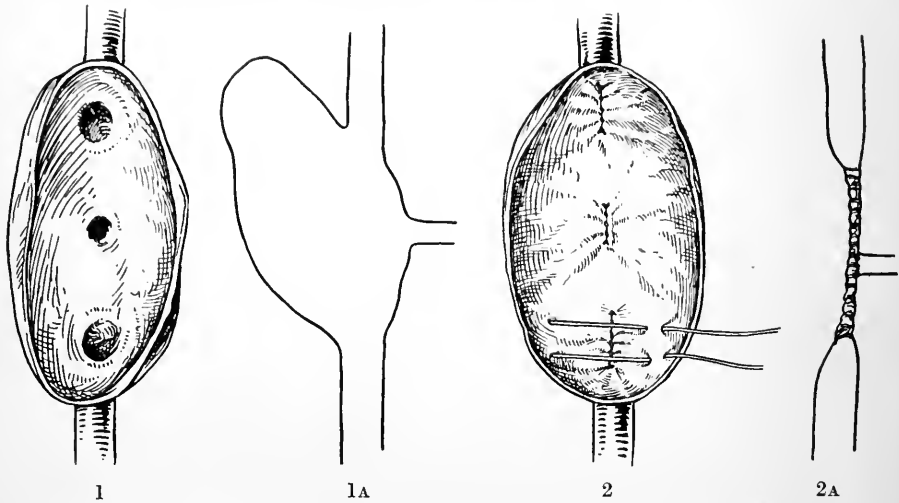
Fig. 11. To illustrate cure of aneurysm by suture (obliterative method of Matas). 1, Showing the opening of vessels into the sac. 1a, Section of same. 2, The apertures of the vessels closed. Commencement of obliteration of sac. 2a, Section of obliterated sac.

that it is likely to be easier and carries less risk of injury to surrounding structures matted in the wall of the sac (Fig. 11).

(2) *The Restorative Method* (Matas) is only possible occasionally in cases where a saccular aneurysm communicates with a normal vessel through a small aperture, *i.e.* in cases following localized injuries of arteries. In such cases the sac may be opened, the clots turned out, and the aperture in the arterial wall sutured, the sac being then folded up over this by sutures to reinforce the weak spot in the arterial wall.

(3) *The Reconstructive Method* has been suggested in case of fusiform aneurysm or a mixed saccular and fusiform aneurysm, the lumen of the vessel being reconstructed by suturing and so reduced to its normal calibre. As, however, the wall in such a case is diseased, it will be likely to dilate again after suture, besides not being of very good material to hold a long line of stitches ; hence this method is not advised.

To sum up, Matas's operation is the method of election when it is possible temporarily to obstruct the circulation through the sac either with a tourniquet or by a temporary clamp on the main vessel above the sac. The

operation should be of the obliterative type, the artery being blocked as well as the sac, except in a few instances of traumatic aneurysm, where it may be possible to close a small aperture in the arterial wall, which is otherwise normal.

(4) *Amputation.*   This is seldom practised unless complications have arisen such as extensive gangrene of the limb, or leaking and suppuration of the sac, or where the limb is rendered useless by pressure-atrophy of bones, paralysis of nerves, &c.

Amputation at the shoulder-joint has, however, been practised success-fully for cases of subclavian aneurysm which failed to react to ligature. The ablation of the limb so reduces the flow of blood through the sac that clotting and healing have taken place.

TREATMENT OF COMPLICATIONS.   Where leaking or suppuration occurs operative measures become urgent, owing to the danger from gangrene, or external bursting and fatal hæmorrhage.   Where possible a tourniquet is applied above the sac and an operation of the obliterative type is carried out.   In cases where suppuration is actually taking place there is much risk of secondary hæmorrhage from the operation wound, and ligature of the main artery higher up will be needed ; should this fail to check the bleeding, or should gangrene take place, amputation is the only resource.

ANEURYSMS OF SPECIAL ARTERIES

Thoracic, *i.e.* aortic or innominate, aneurysms are fusiform at their onset but become saccular later.   These cases are commonly under the care of physicians, but the advances in intrathoracic surgery and the increased scope for surgical interference render a few words on this subject not out of place.

THE ASCENDING AORTA.   Aneurysms of the intrapericardial portion seldom attain any considerable size or produce symptoms till sudden death occurs from rupture into the pericardium.

THE AORTIC ARCH.   Aneurysms in this situation produce different effects, according to the direction in which they expand.

(*a*) When projecting forward great pain is caused by pressure on the thoracic wall, which gradually gives way and a pulsating swelling, dull on percussion, appears on the right of the sternum, while pressure on the innominate veins may cause œdema of face and one or both upper extremities.

(*b*) Upward growth produces a pulsating swelling in the episternal notch and pressure on the great veins.

(*c*) When projecting back and downwards (the usual form) there is dyspnœa from pressure on the trachea and bronchi, dysphagia from pressure on the œsophagus (important when considering the passing of bougies for the diagnosis of œsophageal dysphagia, lest in so doing an aneurysm be made to burst, causing fatal hæmorrhage).   The left recurrent laryngeal nerve is often paralysed in these cases, the left vocal cord being in the cada-veric position, while the voice is hoarse and a harsh " brassy " cough fre-quent.   The heart is usually hypertrophied, so that the apex-beat is displaced

out and down, while a systolic murmur is heard over the tumour. If the patient stand upright with the neck extended and the observer takes hold of the cricoid cartilage a transmitted impulse with be felt (*tracheal tugging*). These signs are most noticeable when the arch is affected. The aneurysm will be further revealed by the presence of an area of dullness on percussion in front of the chest, above the cardiac dullness or behind. Radiographs will often be of value in obscure cases. Should the aneurysm spread into the innominate the corresponding pulses will be delayed and diminished in volume.

THE DESCENDING AORTA. Aneurysm in this situation will cause dysphagia from pressure on the œsophagus, and great pain from pressure-erosion of the vertebral bodies. Sometimes one bronchus is blocked by pressure, causing bronchiectasis.

Treatment. Since these aneurysms are fusiform to a considerable extent, it is clear that energetic efforts at treatment, causing clotting in the whole sac, are out of the question, and reliance must be placed on general methods—diet, recumbency, and administration of iodides and calcium salts—to promote slow clotting on the weakened wall and so to buttress it up against the internal stress. In other words, treatment can hardly be more than palliative. Where, however, a saccule is present and rapidly increasing, some attempt may be made to obliterate this diverticulum by local interference. Acupuncture and wiring may be tried in selected cases. Distal ligature of some of the branches (usually the carotid and subclavian on one side) has met with temporary success.

THE ABDOMINAL AORTA. Aneurysm of this part of the vessel is less common than in the thorax, and is usually situated about the cœliac axis or near the bifurcation.

Signs. There will be a pulsating tumour in one or other of these situations. In addition there may be erosion of the vertebræ, causing pain and, later, paralysis from pressure on nerves. The femoral pulses are delayed. Still later, when leaking into the retro-peritoneal tissues, the condition may closely resemble a rapidly growing sarcoma.

Diagnosis. From a simple throbbing aorta the presence of an actual tumour will decide. In early cases radiographs will often throw light on obscure pain due to aneurysm, which has to be distinguished from caries of the spine, renal colic, neuritis, and tumours of the cord.

Treatment. General measures are usually adopted, though temporary successes are reported from acupuncture and wiring, as well as by partial occlusion of the aorta with a flat band of metal (Halstead). Complete ligature of the aorta has not yet been completely successful, but the results up to date show that under favourable conditions it might be successfully tied below the origin of the renal arteries.

DIAGNOSIS OF ANEURYSMS AT THE ROOT OF THE NECK. Aneurysmal swellings here may be of the aorta, innominate, carotid or subclavian, and diagnosis may not be an easy matter, since the aorta as well as its branches may be affected. Aneurysm of the arch tends to present in the episternal

notch, of the innominate between the heads of the sternomastoid, of the carotid under the inner head of the muscle, and of the subclavian outside the external head, *i.e.* in the posterior triangle ; these signs, however, are subject to variation, since aneurysmal bulgings of the same vessel may expand in various directions. Alteration in the pulses and paralysis of the recurrent laryngeal nerves will help, as well as the tracheal tug, while percussion of the chest and radiographs will show if the aorta is affected.

INNOMINATE ANEURYSM. This is usually fusiform and often associated with a similar condition of the aortic arch. The swelling originally presents between the heads of the right sternomastoid above the sterno-clavicular joint, but may spread inward into the episternal notch, or out into the posterior triangle. The right radial and temporal pulses are small and delayed. As both right and left innominate veins are in relation to the vessel, either or both sides of the face and one or both upper limbs may be œdematous. Pressure on the trachea, œsophagus, brachial plexus, and sympathetic may also be noted, the latter causing dilatation of the pupil.

Treatment. In a few instances cure will result from general measures, otherwise the choice lies between distal ligature of the right subclavian and carotid arteries, performed at the same operation, in order to slow down the blood-stream. Where from the size of the swelling these operations are impracticable, acupuncture or wiring may be tried. The last measure may be used as well as distal ligature to accelerate clotting in the sac.

ANEURYSM OF THE COMMON CAROTID. This is the most common of external aneurysms in women, and affects the vessel near the bifurcation ; when at the origin it is usually part of an innominate aneurysm. The diagnosis has to be made from pulsating goitre and tumour or abscess over or under the vessel.

Treatment. Proximal or distal ligature is often successful, but probably the best method is obliteration of the sac by excision, or preferably by Matas's operation.

THE EXTERNAL CAROTID AND CERVICAL PART OF THE INTERNAL CAROTID. These vessels are seldom affected and usually as the result of injuries. In addition to the usual signs there will be pressure on the pharynx and hypoglossal nerve, causing paralysis and atrophy of half of the tongue. Care is needed not to mistake the bulging into the lateral pharynx of an aneurysm of the internal carotid for a tonsillar abscess, as opening the swelling will prove disastrous.

Treatment. The most generally useful plan is proximal ligature, usually of the common carotid. Where, however, the external is the affected branch, it will be reasonable to place a temporary clamp on the common trunk and attempt to perform Matas's operation on the sac, since the internal carotid should never be occluded if this can possibly be avoided. Aneurysmal varix sometimes is found in this situation between carotid and jugular, resulting from stabs or gunshot wounds with small-bore bullets. This is likely to interfere with cerebral circulation, causing headache, giddiness, and an annoying bruit.

Treatment. The affected artery should be tied above and below the site of the anastomosis with the vein.

INTRACRANIAL ANEURYSMS. These are usually of the carotids, but also of the basilar artery, and result from syphilitic arteritis and infective embolism from detached cardiac vegetations. These affections are seldom diagnosable, being often latent for some time, and later causing headache from erosion of the skull and perhaps giving signs of intracranial pressure ; finally they burst into the cranium and death from coma results. Occasionally a loud murmur heard over the skull may assist in making the diagnosis.

Treatment. Ligature of the carotid or vertebral which controls the vessel, if this can be ascertained.

RETRO-ORBITAL ANEURYSM OR ANEURYSMAL VARIX OF THE CAVERNOUS SINUS. This condition is sometimes known as " orbital aneurysm " and is noted clinically as " pulsating exophthalmos."

This affection depends on various conditions, some of which are never accurately ascertained owing to their being cured by operation. The commonest in practice is aneurysmal varix of the cavernous sinus and internal carotid artery, following injuries such as fractures of the base of the skull and punctured wounds of the orbit. Less common conditions are intracranial aneurysm of the ophthalmic artery, thrombosis of the cavernous sinus, or cirsoid aneurysm affecting the ophthalmic artery.

Signs. This condition usually follows a fall on the head, possibly associated with signs of fracture of the base of the skull. The patient becomes aware of a persistent systolic bruit in the head, which can also be heard with the stethoscope. The eye on one side becomes proptosed (exophthalmos), congested, œdematous, and pulsating. The movements of this eye are impaired and vision is affected, partly by pressure on the optic nerve, partly by alterations in the nutrition of the cornea, due to the exposure from the protrusion of the eye.

Treatment. It is usually found that compression of one carotid causes the pulsation to cease, and if this vessel be tied the condition will often be cured, the proptosis and pulsation passing off.

SUBCLAVIAN ANEURYSM. This is usually found in men who use the arms in laborious occupations, such as porters and sailors. Any portion of the vessel may be affected, but the third part is the usual site of aneurysm. The tumour presents outside the sternomastoid in the posterior triangle and slowly advances down and outward, rarely passing inward, and bursting into the thorax. The pressure effects are on the brachial plexus and veins of the arm, causing pain, œdema, and paralysis ; occasionally the phrenic is involved, causing hiccough. The radial pulse is small and delayed.

Diagnosis. The condition most resembling this is a pulsating sarcoma, though the elevation of the vessel by a cervical rib has occasionally led to error.

Treatment. This is unsatisfactory owing to the large number of collateral branches feeding the sac. Acupuncture and wiring, with or without electrolysis, have been successful, and may be tried as initial measures. If

such treatment fail, as is likely, distal ligature (of the third part of the sub-clavian or the axillary) would appear feasible, but owing to the number of branches is not likely to prove successful unless combined with amputation of the arm at the shoulder, and should therefore be kept as a last resource. This leaves proximal ligature or tying the innominate artery, with which must be combined ligature of the carotid and probably of the vertebral as well. If such measures be contemplated it would seem reasonable to secure these vessels by temporary clamps, and then, if the pulsation in the sac is well controlled, open the latter and secure the feeding-vessels inside, finishing after the fashion of Matas.

AXILLARY ANEURYSM. Like subclavian aneurysm, this occurs in patients whose work is laborious, but also from injuries to the artery in fractures or dislocations of the upper end of the humerus and from punctured wounds of the vessel. The swelling may be immediately below the clavicle or lower in the axilla. At first small and well-defined, the aneurysm tends to grow rapidly and may push the clavicle up, encroaching on the neck and rendering proximal ligature difficult. Pressure on the veins and nerves gives the same effects as in the subclavian form.

Treatment. Proximal ligature of the third part of the subclavian may suffice, but in the large and more rapidly growing forms this part of the vessel may be difficult to reach, and it will be better temporarily to clamp this part of the subclavian and the axillary distal to the sac and then lay open the latter and secure the entering vessels (Matas's operation).

Aneurysms of the vessels of the arm lower down can readily be treated by excision or obliteration. Where aneurysmal varix is present the artery is tied above and below the communication.

INGUINAL AND ILIAC ANEURYSMS. These are found in the iliac fossa or in the vicinity of Poupart's ligament, forming in the common or external iliac, or the common femoral. They produce pressure on the veins and nerves of the lower limb. In the early stages the appearance of the pulsating swelling is unmistakable, but later, if becoming diffuse, these aneurysms may closely resemble sarcoma, abscess, or enlarged glands in relation to the artery.

Treatment. Where the aneurysm is small it may be possible to approach by the extra-peritoneal route through muscle-splitting incision (as for exposing the appendix or ureter) and stripping the peritoneum from the iliac fossa till the common iliac is reached. This may be clamped tem-porarily and extirpation or obliteration of the sac accomplished, or the main vessel tied (proximal ligature). Where the sac is very large and diffuse the extra-peritoneal route will hardly be possible, in which case the common iliac is exposed by laparotomy, packing off the intestine, and tied. It would seem reasonable in addition to tie the external iliac distal to the sac above the epigastric branch if possible. The results of these cases have not been satisfactory.

GLUTEAL ANEURYSM. A pulsating tumour of the gluteal region may be due to aneurysm of the gluteal or sciatic artery, and usually results from a

punctured wound. Laparotomy and ligature of the internal iliac artery in the pelvis is the best course in these cases.

FEMORAL ANEURYSM. Aneurysm of the superficial femoral may occur in Scarpa's triangle or Hunter's canal, and is often of traumatic origin. Aneurysm of the deep femoral is distinguished by being confined to Scarpa's triangle, and by the fact that the pulses in the leg are not altered as in the case of the superficial femoral aneurysm, while the latter vessel may be felt in front of the sac.

Treatment. Obliteration of the sac by Matas's method is the operation of choice after placing a temporary clamp on the common femoral above and the superficial division below. This will be better than ligature of the common femoral.

Aneurysmal varix should be treated by dissociating the vessels and suturing if possible, since if the artery be tied above and below the junction there is considerable risk of peripheral gangrene.

POPLITEAL ANEURYSM. This is the commonest external aneurysm in men, and may be due to the fact that the vessel is constantly being flexed and stretched as well as undergoing definite injuries of various magnitudes. There is a history of syphilis in most cases. The swelling presents the usual characters, and later may erode the bones and invade the knee-joint. The type is usually saccular, and pressure on veins and nerves causes paralysis and œdema, while the joint is commonly flexed.

Diagnosis is simple in the early stage, but when becoming diffuse it may be confused with sarcoma of the bones, affections of the joint, or suppuration of the popliteal glands. The chronicity will readily separate from the more acute infections, while radiographs may be of assistance in difficult cases.

Treatment. This is the classic site for Hunter's operation (proximal ligature at a distance), the femoral artery being tied in Hunter's canal. This is a simple operation and the results are very fair, most cases being cured of the aneurysm, but a varying degree of gangrene of the feet or toes is a fairly common concomitant. Consequently, the operation of choice would appear to be obliteration of the sac by Matas's procedure, taking special care of the popliteal vein if the latter be not already thrombosed or obliterated. Local measures of this type are undoubtedly preferable to Hunter's operation where the aneurysm is leaking or suppurating or if there be much œdema.

Where gangrene is present, the knee-joint disorganized, or secondary hæmorrhage is taking place from an inflamed or leaking sac, amputation is the only treatment.

Aneurysmal varix is sometimes met with in this situation, and demands the usual treatment.

Aneurysms below the popliteal are usually of traumatic origin and treated by excision or obliteration of the sac.

INFLAMMATIONS AND DEGENERATIONS OF VEINS

INFLAMMATIONS OF VEINS (phlebitis). From a practical point of view the inflammations of veins may be divided, according to the sort of clot which forms inside them, into simple and suppurative or infective. Probably most cases of phlebitis are infective, with the exception of the plastic healing process which takes place after injuries, ligatures, &c. Various reasons are brought forward to account for non-suppurative thrombosis of veins, such as prolonged rest and stagnation in bed, but these alone will not cause thrombosis unless there is some source of infection present such as enteric fever or appendicitis.

(a) *Simple Phlebitis.* The wall of the vein becomes congested, red, infiltrated with round cells, and the intima becomes roughened and altered, so that clotting takes place inside the vessel (thrombosis). Changes in thrombi have been already mentioned, resolution, canalization, fibrosis, and detachment causing embolism. Since in simple phlebitis the clot is firmer and less friable than in the infective cases, there is less likelihood of embolism taking place, but should such detachment of clot occur a much larger embolus will result, and one which will much more effectively block the pulmonary vessels. Hence, while in (suppurative) phlebitis and thrombosis multiple small embolisms are frequent, in simple phlebitis large embolisms, though occurring less often, are likely to cause severe trouble in the pulmonary circulation, and possibly death may result.

Phlebitis and thrombosis of veins are practically inseparable, phlebitis being the initial condition. As the underlying cause is infection, there is always some chance that a simple may develop into a suppurative thrombosis. Simple phlebitis is much more common in the lower limbs, especially in the saphenous vein, where varix is an important predisposing cause ; also in the femoral and pelvic veins from mild infections of puerperal, appendicular, or typhoid origin, or following pelvic operations, &c. The axillary vein is rarely affected, and the cause then is generally obscure.

Signs. There is pain in the region of the vein, congestion and œdema of the skin drained by the vein in question, while slight fever is usual. Where the vein is superficial, as the upper part of the femoral or saphenous vein, it may be felt as a tender cord lying in the position of the vein. The signs of phlebitis, then, are the same as those of thrombosis except for the pain and tenderness of the vein, and unless thrombosis takes place phlebitis can hardly be diagnosed ; such a condition, however, is improbable. In most instances the vein becomes pervious again by canalization or absorption of the clot, while collateral, venous circulation is increased after a few weeks. During the first few days there is danger of the clot being detached, causing pulmonary embolism, or it may break down and suppurate, producing an intravenous abscess, or infective embolism, though these terminations are uncommon. The œdematous condition of the limb may last a long time, and often there is permanent enlargement of the limb, although the functions may be perfect.

Suppurative or Infective Phlebitis. This term is applied to cases where the infection is more virulent, the clot readily breaking down by suppuration and passing into the circulation in the form of emboli, which lodge in the lung and are the cause of a general infection (pyæmia). The infection usually reaches the vein from outside, very commonly from infective disease of bone (acute diaphysitis, mastoiditis), or passes into the pelvic veins from puerperal infection, into the portal tributaries from appendicitis or infected hæmorrhoids.

The wall of the vein undergoes similar changes to those found in the simple form but of more severe character. Thrombosis takes place on the altered intima, and as the clots break down rapidly, passing off as emboli, there will be a succession of small infective emboli discharged into the circulation, causing pulmonary abscesses, but are seldom large enough to cause gross pulmonary embolism.

The outlook of these cases is very grave, for unless the infective emboli can be prevented from entering the circulation hopeless pyæmia will result.

Signs. A succession of rigors with swinging temperature, associated with the presence of some actively infective focus—*e.g.* otitis media, appendicitis, or an infected uterus, &c.— render diagnosis probable. Where the vein is superficial it may be felt tender and thickened, and later the skin over it may become red and the vessel softens and finally bursts as an abscess. Such local signs, however, are often but slightly in evidence before a grave general infection has taken place. Many small emboli can be thrown off from the infected interior of a vein before it is completely occluded ; indeed if completely blocked, the blood-flow being cut off, there is less danger of emboli being detached.

Treatment. (*a*) *Simple Phlebitis.* Any patient suffering with phlebitis and thrombosis must be considered to be in a serious condition, since there is always a possibility (fortunately often remote) of the clot separating and causing grave or fatal pulmonary embolism. Such patients must be handled carefully, and no roughness in moving the thrombosed part is permissible. Complete rest is advisable, the affected limb being raised (the leg elevated on an inclined plane if the saphenous, pelvic, or femoral veins are affected, or the arm slung when the axillary vein is thrombosed). After three weeks the process of organization in the clot will be as a rule sufficiently firm to permit of movement and massage may be gently commenced, but only when all pain has ceased and there are no signs of inflammation in the vein. In the early stages fomentations will relieve the pain ; glycerine of belladonna, which is often applied, is messy and impressive but of questionable benefit. Should such a vein break down and suppurate, the abscess should be opened as usual.

Where the vein is superficial, as in the case of the saphenous, it is a good plan to tie the vessel proximal to the clot to prevent further spread. Having done this, it will be just as well to remove the thrombosed vessels, since in most instances the incisions will heal just as quickly as the clots, if left, will become soundly organized, and the condition will be more effectively cured.

(b) *Suppurative or infective phlebitis* is far more serious from the resulting pyo-septicæmia. The best method of treatment is to occlude the vein on either side of the inflamed and thrombosed part, to open the vein and remove the infected clot. This method is very fairly successful in cases of lateral sinus thrombosis, and successful results are also reported of proximal ligature of the uterine and ovarian veins for infective thrombosis of uterine origin. Removal of sloughing hæmorrhoids to prevent portal pyæmia is an operation of this nature. In the case of peripheral veins this treatment is often impracticable, and if the course of general infection is not arrested by dealing with the initial focus, *e.g.* by draining gangrenous cellulitis or removal of acutely necrosing bone, amputation will be needed to save the patient's life.

VARIX OR VARICOSE VEINS. In this condition the veins become distended, elongate, and tortuous. In fact, allowing for the underlying differences in structure and function, the condition of varix holds much the same position in the pathology of veins as do arterio-sclerosis and aneurysm in the case of arteries.

Causes. This condition is due to local alteration in the walls of the veins, together with increase in the intravenous pressure, whether general or local.

(1) The most important condition affecting the wall of the vein is a natural or congenital inability to resist increase of intravenous pressure. That this deficiency is congenital is shown by the family history and by the development at adolescence of many cases. Whether the deficiency is in the elasticity of the wall or of incompetence of the valves of the veins, or the two combined, is uncertain. Valvular incompetence is often noted in cases of varicose veins, but how far a cause and how far a result of the varicosity is doubtful. A degenerative condition of the wall is found in varicose veins akin to atheroma of arteries, the wall being thicker, less elastic, and prone to inflammation. This condition is known as *phlebosclerosis*, and may be the cause of the varicosity, but is just as likely to result from the slight injury caused by constant over-distension in veins with congenitally deficient walls.

(2) Increase of intravenous pressure arises from many causes :

(a) From obstruction in the veins themselves, such as arises from fibrosis of thrombi.

(b) From pressure of structures outside the vein, as cirrhosis of the liver, producing increased pressure in the portal system and dilatation of the hæmorrhoidal veins (piles), of the gastric and œsophageal veins and of those of the spleen (one form of splenomegaly). The pressure of abdominal tumours of rapid growth, especially pregnancy, which is the great cause of varicose veins of the lower limbs in women. Tight bands around limbs, of which garters are the best instance.

(c) A general rise of the intrathoracic pressure from straining in laborious occupations or sports is a factor of some importance in producing varix. Gravity, always acting while the human organism is in the erect

position, plays a considerable part, as evidenced by the great preponderance of varices in the lower limb, especially where long standing is part of the patient's occupation. Gravity, together with want of support by surrounding tissues, accounts to a large extent for piles, varicocœle, and varicose veins of the lower extremity. Some distinction (in practice) should be drawn between compensatory dilatation of veins (as occurs in the anastomosis of the epigastric and internal mammary after blocking of the vena cava) and ordinary varix, though pathologically the conditions have much in common.

The situations where varix demands surgical attention are the lower limb (external and internal saphenous veins), the hæmorrhoidal and spermatic plexuses ; the last two conditions (piles and varicocœle) are considered elsewhere, the veins of the lower limb alone being considered here.

Anatomy. The middle coat of the vein becomes atrophic so that the elasticity is lost, but the thickness of the vessel is increased by excess of fibrous tissue, so that such veins gape when cut across. In some parts, however, the wall becomes thinned, dilating into pouch-like processes, and if these are next the skin, which also becomes atrophic, the vessel may burst through on to the surface, causing severe hæmorrhage. The valves are atrophic either congenitally or as a result of the above-described changes of the wall.

Results of Varix. Owing to the imperfect return of venous blood along the tortuous vessels, skin drained by the affected vein is poorly nourished and readily irritated by clothing or dirt, so that eczema may result, which is apt to become chronic with pigmentation of the affected skin. Slight injuries and scratches do not heal readily owing to the lowered vitality of the tissues, and ulcers arise which tend to spread at varying speed, often lasting a lifetime if not treated with care, and are the commonest form of ulcer of the leg. Phlebitis and thrombosis are common complications of varix, due to injury or mild infections, and setting up an inflammation which may cure the varicose condition if localized, the vein becoming fibrosed and obliterated. The other terminations of thrombosis have been detailed. Next to pulmonary embolism hæmorrhage from bursting of thinned pouches of these veins is the most important complication, and is readily checked by placing the patient recumbent and elevating the limb while moderate pressure with pad and bandage is made on the bleeding-point.

Signs. The limb feels full, especially after long standing, and is easily tired, while in well-marked cases there is pigmentation or eczema of the skin of the inner and lower part of the leg. The tortuous veins are readily seen and felt under the skin, appearing as worm-like swellings of the larger veins affected, but where the trouble is more in the smaller veins these show a stellate or arborescent dilatation of the vessels in the skin itself. In the larger veins an impulse on coughing can often be felt some distance down the limb : where there is much œdema or periphlebitis the vein may be indistinct.

Varix at the Saphenous Opening. Where the upper end alone of the saphenous vein is varicose the presence of a reducible swelling with an impulse on coughing in the region of the femoral opening will suggest a femoral hernia. There is, however, no gurgle on reduction, and if reduced and the finger placed on the ring the swelling will reappear from below if the condition be varix but remain reduced if hernia be present. (*See* Femoral Hernia.)

Treatment. Where the enlargement of veins is compensatory, as in the dilated epigastric veins already mentioned, they should be let alone. Hæmor-

Fig. 12. Varicose veins principally involving the external saphenous vein.

rhoids and varicocœle are discussed later ; we refer here to varix of the lower limb.

General Measures. Regulating exercise and avoiding excessive strains, long standing, and constipation will be obvious but often difficult to attain in those who have to work for a living.

Local measures consist in supporting the veins or removing them.

(*a*) *Palliative or Supporting Treatment.* Various appliances are used. Crêpe Velpeau bandages, elastic stockings, and rubber bandages, in order of strength, may be employed with satisfaction where the patient is in good circumstances and can keep the limbs clean (washed twice daily), powdered and massaged, and will be suitable for older persons or where the cause is

transitory, as pregnancy, but care of the skin is needed or eczema and ulceration will follow.

(b) Operative measures are indicated in the young and active or in poor people who have difficulty in obtaining fresh appliances and managing the hygiene of the skin, and where complications in the form of eczema, ulceration, thrombosis, or hæmorrhage occur or large pouches threaten to burst and bleed.

The operation performed varies with the condition present, of which there are three main types :

(a) The greater part of the large trunks (external or internal saphenous) are affected, the branches being little enlarged ; this is usually in young persons.

(b) A local affection of the large trunks with formation of circumscribed masses of tortuous veins of comparatively small extent.

(c) The smaller veins and venules are most affected, the larger vessels but slightly ; this type is found in the old and after repeated pregnancies.

(a) In these cases the valves will be inefficient and an impulse on coughing felt far down the leg. Hence it is necessary to obliterate the saphenous vein by ligature close to its junction with the femoral at the saphenous opening (Trendelenberg), in order to remove the weight of the superincumbent column of blood from the lower veins. The remainder of the dilated veins may be dealt with in various ways.

(1) Portions two to three inches long may be excised at intervals, especially where anastomoses are found ; removal of two or three pieces will suffice.

(2) Through small incisions at intervals portions of the vein may be twisted out after division (Mitchell) or removed by " strippers " passed outside the vein (Mayo), or a bulb-ended " stylet " passed into its lumen (Babcock).

The stripper encircles the vein and is pushed along the latter as far as possible, stripping the vessel from its bed. The stylet is pushed along inside the vessel a foot or more, the end of the instrument then exposed by a second incision, a ligature tied round below the bulge of the stylet, thus fixing the vein, and on pulling the instrument a length of vein is torn out. These plans are better than removal of the vein through a thirty-inch incision, as has been done in the past.

(b) Where local bunches of dilated veins are present they are dissected out : the question of tying the saphenous vein high up depends on the integrity of the valves.

(c) Diffuse affection of the venules is unlikely to be improved by operation. Tying the saphenous high may improve ; some advise multiple, circular skin-incisions, cutting through the veins in a circular manner so that their course is interrupted by the resulting fibrosis.

After operation the patient remains recumbent for at least fourteen days and wears a light crêpe Velpeau bandage for a few weeks while walking and standing.

Ulcers and thrombosis are not contra-indications for operation, but rather render it more necessary. Ulcers should be cleaned and grafted by the Thiersch method, while the veins may be excised at the same operation.

NEW GROWTHS OF BLOOD-VESSELS (angeiomas). These most commonly take origin in capillaries (nævi), less often commencing in arteries, and are often congenital.

(a) *Nævi.* These tumours are of congenital origin (birth-marks), seldom arising later in life. They are most usual under the skin or mucous membranes, but also occur in internal organs such as the liver or kidney. The tumour consists of an increase in the number of the capillaries, which are distended and may dilate into cystic spaces. It is uncertain to what extent arterioles and venules participate in their structure, but the colour of these tumours varies from bright red to dark purple, so that there can be little doubt that the affection involves more than merely the capillaries.

Two main varieties are distinguished, capillary and cavernous, though all sorts of intervening conditions are found.

(1) *Capillary or Cutaneous Nævi.* These consist of collections of capillaries more or less dilated and set close together in the dermis, over which the epidermis is thin and often devoid of glands and hair. In the form of " port-wine stains " they are found as red or purple patches, usually well defined, which may be flat or raised above the surface (in which case they are partly cavernous), *i.e.* contain blood spaces of some size. Owing to the tenuity of the epidermal covering ulceration is not infrequent, leading to infection, thrombosis of the vessels, subsequent fibrosis, and a natural cure of more or less of the nævus. Superficial nævi are often multiple, and vary in size from a pin's point to an area covering half or more of the face.

(2) Cavernous nævi, which are often subcutaneous, consist of blood-spaces of some size connected with dilated capillaries ; they are often combined with superficial nævi of the skin, but may be entirely subcutaneous, in which case the blood seen obscurely through the skin gives them a bluish appearance. In other instances they are mixed with a considerable amount of fat and loose connective tissue, being then described as nævo-lipomas.

Diagnosis is usually simple, but where occurring in the mid-line of the skull or spine they are distinguished from meningocœles, &c., by the absence of pulsation and impulse on coughing or crying.

Treatment. Small nævi which are not growing and situated on inconspicuous parts may be left alone. When removal is deemed necessary for cosmetic or other reasons excision is usually the simplest method ; care is needed to remove a margin of normal tissue or recurrence is likely, since the edge of the nævus merges indefinitely into the surrounding structures.

In some parts of the face, *e.g.* the eyelids, excision may cause awkward scarring, and other methods will be more suitable. Punctures with a fine needle-pointed, electric cautery is useful for the more succulent forms, while large flat port-wine stains may be effectively treated by application

of solid carbon dioxide for thirty to sixty seconds. This produces localized frost-bite, and is followed by œdema, inflammation and fibrosis, so strangling the vessels. Radium also gives good scars.

For large succulent growths of the cavernous type electrolysis with several needles is useful, though the new plan of punctures by the method of Diathermy will probably supplant this.

(b) *Arterial angeiomas* (*cirsoid aneurysm*, &c.). Several terms are applied to tumours in the formation of which arteries take a predominant part, and these terms are used in different senses by various writers, the most important point about such growths being that dilated, tortuous arteries are present. The following distinctions may be made : A cirsoid aneurysm denotes a tumour made up entirely of dilated and tortuous arteries; an aneurysm by anastomosis is where veins and capillaries also are present in the tumour ; while in arterial varix a single artery becomes dilated and tortuous like a varicose vein.

Fig. 13. Nævo-lipoma of the neck.

Cirsoid aneurysms are commonly situated in the scalp, very usually arising in the temporal artery or its branches, but steadily spreading, involving and forming larger trunks till the whole scalp is affected. Ulceration arises from pressure of the dilated arteries, and these give way, causing profuse bleeding.

The appearance of a tumour containing tortuous, pulsating vessels is characteristic, and often a systolic bruit is present.

Treatment. This is often difficult owing to the size of the tumour and the free hæmorrhage encountered whilst operating. Excision while still small is the best line to take, but it is well to remove plenty of tissue or some of the tumour may be left and growth recur. During the operation, if on the scalp, an elastic tourniquet may be placed round the skull just above the ears from the glabella to the occiput, to control the hæmorrhage.

When excision is impracticable from the size, the main vessels leading to the tumour should be tied, and it is advised that boiling water be injected into each before tying. This will cause wide thrombosis and shrinking of neighbouring vessels, while from the great vascularity of the growth there is no risk of sloughing taking place ; the difficulty is to cut off the blood-supply sufficiently.

OPERATIONS ON BLOOD-VESSELS

Until recently operations on blood-vessels were practically confined to the application of ligatures. In the last decade, however, thanks to the work of Carrel, Guthrie, Murphy and others, suturing and anastomosing operations have been successfully conducted, and although the suturing of vessels has not hitherto attained the success and facility arrived at in similar operations on the abdominal viscera, they now occupy a recognized place in practical surgery and hold out considerable promise for the future. The main difficulty consists in the formation of thrombi around sutures, but this has been largely overcome by care in technique and the use of sutures of fine silk soaked in sterile vaseline, while the protrusion of any tissue except normal endothelium into the interior of the vessel is carefully avoided by eversion of the intima, the plan of procedure being in this respect just the reverse of that obtaining for intestinal suturing, where invagination of the peritoneum is practised to avoid risk of contamination. The following operations are considered : suturing, anastomosis, and ligatures.

Fig. 14. End-to-end suture of an artery (Carrel's method). 1, Guide-sutures inserted. Rubber-faced clamp in position. 2, Two guide-sutures pulled taut : over hand-suture of intervening segment of vessels.

(1) Suturing of Vessels (arteries). This may be used to repair accidental or surgical wounds of vessels, in performing anastomosis, or for inserting a graft where a portion of a vessel has been removed and there is too large a gap to admit of performing an end-to-end anastomosis.

Carrel's method is as follows : The suture-material is the finest silk, sterilized in liquid vaseline and passed with the finest sewing-needles. The vessel must be clamped temporarily above and below the site of suture with forceps which will not injure the vessel (rubber-covered intestinal clamps serve well). The blood is gently pressed out of the ends of the vessel in the devascularized area and washed away with normal saline.

The adventitia is dissected back for a short distance and the edges to be sutured touched with liquid vaseline. The edges of the vessel are not brutalized by picking up with forceps to insert the sutures but the needle passed straight through.

Where there is a wound partly dividing the vessel it is sutured with a continuous suture, taking up all the coats except the stripped adventitia. The sutures may be passed as a continuous mattress to evert the intima, though if a guide-suture be placed at each end of the incision in the vessel there will be sufficient eversion by using the ordinary overhand stitch, and the lumen of the vessel is less narrowed. Where the vessel is cut right across, three equidistant guide-sutures are passed through the ends and tied so as to evaginate the intima. On gentle traction of pairs of the guides the edge of the arterial wall between becomes straight and the circumference is united one-third at a time by continuous suture as before. The sutures are about one-fifteenth of an inch apart. When the suturing is completed the distal clamp is removed and there will be hæmorrhage through the stitch-holes (we are dealing with suture of an artery); this is soon controlled by local pressure with gauze and ceases in about a minute from the formation of small thrombi in the stitch-holes. Should bleeding still continue further sutures may be inserted, but if the edges all round have been accurately apposed these should not be needed. The proximal clamp is then removed, and if all is snug the adventitia and sheath of the vessel closed with a second line of sutures, after which the superficial structures are closed in layers. The most rigid asepsis and avoidance of bruising the intima is needed for success.

Murphy's plan is by invagination of the proximal portion into the distal after stripping the adventitia, and somewhat resembles van Hook's operation for suturing a divided ureter; it seems a less commendable method than the one described and, owing to the overlapping required, uses up more of the vessel (an important point where some of the latter has been excised).

Even where success is incomplete and thrombosis takes place at the suture-line, ultimately obliterating the vessel, this will take some hours or days and gives time for the collateral circulation to become increased, which may make just the difference of the limb being saved from gangrene.

(2) ANASTOMOSIS OF BLOOD-VESSELS. This has mostly been employed to reverse the circulation in cases of incipient gangrene, by diverting the blood from the obliterated or thrombosed peripheral arteries and sending it through the possibly still pervious veins. Though often failing, a sufficient number of successes of varying degree render this operation worth mention, and it may be employed in selected cases. It is usually performed between the superficial femoral artery and vein.

Originally the proximal end of the artery was joined directly to the peripheral end of the vein, tying off the distal end of the artery and the proximal end of the vein. But of late lateral anastomosis of the artery and vein has been done, and the vein tied above the anastomosis. This seems a more reasonable plan, since the blood may travel partly by the

artery as well as along its new course through the vein. The freedom of venous anastomosis prevents any difficulty of venous return. The suturing is performed as in intestinal anastomosis, but the intima is everted and the knots are outside the lumen.

Suturing of Veins is a simple matter in comparison owing to the lower blood-pressure, and may be best performed in a similar manner with vaselined silk. In most instances of surgical injuries a lateral ligature suffices.

Grafting. A segment of vein (the long saphenous being convenient) may be grafted by the circular method where a length of artery has been removed, and even if not permanently successful, will probably maintain the circulation long enough to allow the collateral vessels to dilate and so avoid gangrene. The modifications of suturing suitable for aneurysms have been described.

(3) LIGATURE OF VESSELS. The ligature of vessels at the seat of hæmorrhage has been described. Ligature of arteries in continuity is employed in the treatment of aneurysms, to inhibit the growth of tumours, to check secondary hæmorrhage and before commencing certain operations, in which case the ligature may be (*a*) permanent, as when the glands of the neck are removed and the lingual artery tied before removal of a cancerous tongue, or (*b*) temporary (in which case a clamp is often used) in operations where hæmorrhage is likely to be free and tourniquets are with difficulty applied, as in amputation at the hip. Owing to the infrequency of secondary hæmorrhage and the rarity of external aneurysms, ligature of arteries, with certain exceptions, is becoming uncommon. Their exposure, however, forms a useful training for the student and helps to brush up some of the important points of practical anatomy.

Veins, especially the jugular, are ligatured to prevent infective embolism.

LIGATURE OF ARTERIES. (*a*) *Exposure of the Vessel.* The skin-incision is made usually in the line of the vessel, though in certain places, as for tying the lingual or posterior tibial, the incision is made in accordance with the structures to be encountered before the vessel is exposed. The tissues in the depth of the incision should be divided to the same extent as the skin, so that the opening is sufficient and does not become narrower as it approaches the deeper part of the dissection. Muscles are, as far as possible, retracted or split longitudinally. It is important to recognize the various structures (muscular, bony, ligamentous, or nervous) encountered on the way to the vessel ; these landmarks are described as " rallying-points." When in difficulties the surgeon should retrace his steps to the last rallying-point of which he is absolutely certain, and reconsider the anatomical situation. Mistaking these rallying-points is the chief cause of failure or difficulty in operations, especially when practising on the cadaver ; in the living body the pulsation of the vessel will often be of assistance where anatomical knowledge has become rusty. A useful clue is often given by the fact that the branches of a main vessel pass along intermuscular septa, and where a choice presents itself of dissecting along two or more such septa it will be safe to choose that along which small arterial branches emerge, for the

artery must lie underneath. In the living body an artery is easily recognized by its pink colour, firm elastic feel, and pulsation, while if compressed it will ultimately collapse and feel like a flat cord thicker at the edges than along the centre, and thus can be distinguished from nerve-cords ; this last point helps to distinguish arteries in the cadaver. Veins are easily known by their thin walls, large calibre, and, in the living, by their bluish colour, while near the thorax (in the neck) respiratory movement will be often very obvious. Care should be taken that a zealous assistant does not retract the vessel along with other structures, and when the artery does not present itself readily it is well to remove retractors and go through the structures retracted (rallying-points) afresh.

On arriving at the vessel its adventitial sheath is carefully opened by a three-quarter-inch incision, and the vessel freed from its sheath all round
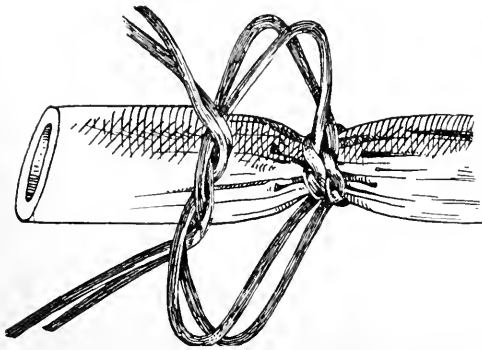
Fig. 15. The " stay-knot " for large arteries, half tied.

by blunt dissection with an aneurysm-needle. The ligature is passed around the vessel with an aneurysm-needle, which is introduced on the side of the most important neighbouring structure (whether nerve or vein) and passed away from such structure so as to more certainly avoid its enclosure in the ligature. The needle may be threaded before or after passing round the vessel. Should the accompanying veins be injured they are tied with a lateral ligature. The ligature is tied and the wound closed in layers.

(b) *Ligatures and Knots.* For medium-sized vessels the ligature may be of silk or chromic catgut and tied quite tight in a reef-knot, paying no regard as to whether the inner coats are completely divided or not. Where, however, the vessel is atheromatous, or calcified and brittle, the ligature should be tied only just tight enough to occlude the vessel, as ligatures easily cut through such weakened brittle vessels, and may come off immediately or after some hours, causing intermediary hæmorrhage. For tying the largest vessels, such as the innominate, subclavian or aorta, and common iliac, it is unsafe to draw the ligature so tight that the inner coats are ruptured, as the intra-arterial pressure may cause the vessel to give way at this point. Hence in these instances the ligature is only drawn just tight enough to obliterate the lumen, and as when this is done the pressure inside the vessel is likely to loosen the first hitch of the knot while the second is being tied, and so cause the obliteration to be incomplete, it is well to pass two ligatures close together and tie the first half-hitch in each separately, the proximal before the distal, and then tie the second part of the knot, using the ends of both ligatures together. By using this " stay-knot " (Ballance

and Edmunds) there is less risk of the lumen of the vessel dilating, as the proximal ligature controls the pressure while the distal is being tied, and the two together occlude the vessel like a flat band which does not bite enough into the wall to cause ulceration and weakening.

(c) *After-treatment.* After ligature of the larger trunks three weeks rest are needed to secure solid organization of the clot in the vessel at the point tied. Meanwhile the limb, which the vessel supplies, should be elevated and kept warm to maintain the circulation and be rendered aseptic by painting with iodine solution and covering with an aseptic dressing till all danger of gangrene has passed.

(d) *Dangers.* Secondary hæmorrhage is rare if asepsis be rigidly practised and care be taken not to crush the inner coats of larger vessels ; this complication will probably lead to amputation of the limb. Should gangrene set in, it will probably be aseptic to commence with and one may wait till a line of demarcation appears, when amputation a short distance above will save much time and the risk of the gangrene assuming a moist, infective and spreading type.

LIGATURE OF SPECIAL ARTERIES. THE INNOMINATE : *Surface-marking.* A line joining the middle of the manubrio-sternal joint with the right sterno-clavicular joint.

Relations. (a) In front : The sternum, sternohyoid, and sterno-thyroid muscles, the left innominate and right inferior thyroid veins.

(b) Externally (right) : The pleura, vagus, and right innominate vein.

(c) Behind and to the left : The trachea and left common carotid.

Collateral Circulation. The circle of Willis in the skull, the junction of the aortic intercostals with branches of the axillary and internal mammary and of the latter with the deep epigastric of the external iliac.

Indications. Wounds of the vessel, aneurysms of the subclavian and carotid near their origin.

Operation. The patient lies in the dorsal position, the head turned to the left. An incision over the inner half of the clavicle joins another passing along the lower part of the anterior edge of the sternomastoid and extending on well down over the manubrium. The flaps thus formed are reflected, the sternomastoid, sternothyroid and sternohyoid are divided. The right common carotid is found easily and ligatured, then traced down to the innominate, which may be sufficiently located thus to pass a ligature. More often it will be necessary to remove the inner part of the clavicle and the right half of the manubrium sterni. The right inferior thyroid vein is divided between ligatures and the innominate artery exposed above the crossing of the left innominate vein. The upper part of the vessel is carefully freed from the pleura and right innominate vein (the phrenic and vagus lie well away to the right). The aneurysm-needle is passed from the outer (right) side to avoid the pleura and right innominate vein. A very thick, soft ligature should be employed and tied with the " stay-knot," only occluding the lumen. The origin of the carotid, and if possible the vertebral, should always be secured as well. Although this operation is

likely to prove difficult and dangerous, it has been successful sufficiently often to render it well worthy of a trial in suitable cases.

THE COMMON CAROTID. *Surface-marking.* The line of the common as well as of its external and internal branches joins the sterno-clavicular
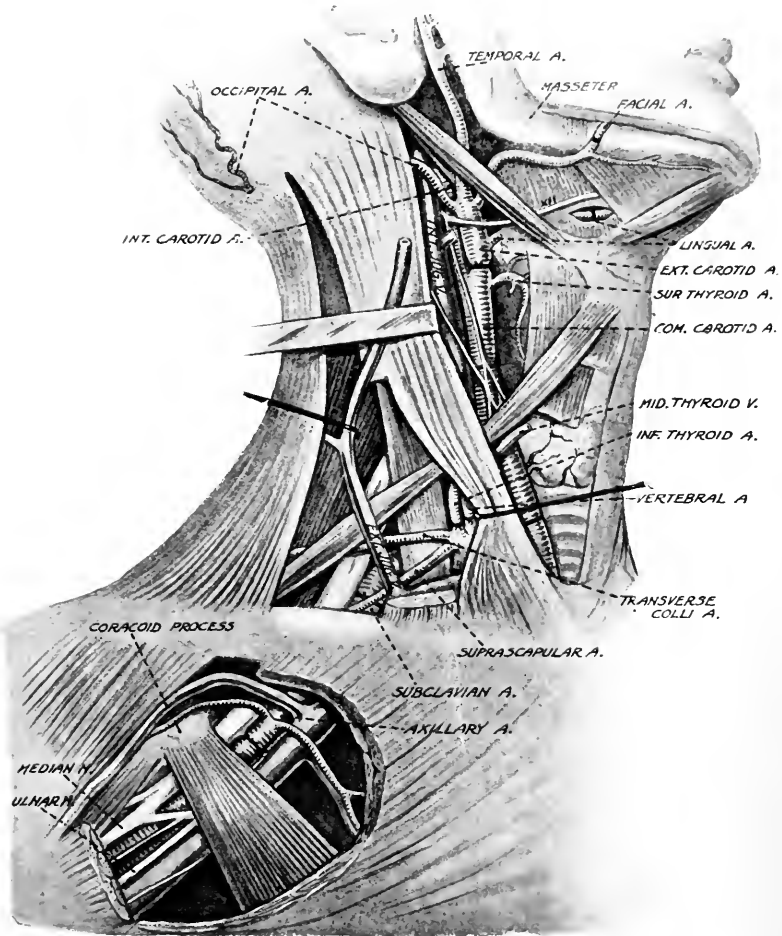
FIG. 16. Surgical anatomy of the carotid and subclavian with their branches, showing the places where ligatures may be applied.

joint with the mid-point between the mastoid process and the posterior margin of the ramus of the jaw. The bifurcation of the common trunk is at the upper border of the thyroid cartilage (the intrathoracic part of the left common carotid need not be considered in operative surgery).

Relations. (a) In front : The sternomastoid, sternohyoid, and sterno-thyroid.

(b) Externally : The vagus and internal jugular vein.

(c) Internally : The trachea, larynx, thyroid gland, and recurrent laryngeal nerve.

(*d*) Behind : The prevertebral muscles, the sympathetic nerve, the recurrent laryngeal nerve, and the inferior thyroid artery.

The common carotid may be tied above or below the crossing of the omohyoid muscle ; the former is the more generally useful place.

Collateral Circulation of the Common Carotid. This principally by the circle of Willis, also by branches of the external carotid anastomosing across the middle line with those of the opposite side and with the branches of the subclavian, such as the superior with the inferior thyroid, the princeps cervicis with the occipital.

(*a*) *Ligature below the Omohyoid. Indications.* Injuries, and as proximal ligature for carotid aneurysm.

Operation. The patient being in the dorsal position with head extended and turned slightly to the opposite side, an incision is made along the lower half of the anterior border of the sternomastoid muscle, which is then retracted outward ; the sternohyoid and sternothyroid muscles are retracted inward or divided ; the omohyoid then comes into view,. crossing the vessel obliquely upwards and inwards.

Fig. 17. Incisions for ligaturing the arteries of the head and neck. 1, Occipital. 2, Facial. 3, Superficial temporal. 4, Lingual. 5, External carotid. 6 and 7, Common carotid. 8, Innominate. 9, Vertebral. 10, Subclavian (3rd part). 11, Axillary (1st part).

This muscle is retracted up and outward. The inferior thyroid veins may require division between ligatures, and the sheath of the vessel is thus exposed and opened, the needle being passed from without inwards to avoid the vagus and jugular vein and kept close to the vessel to avoid the recurrent laryngeal nerve.

(*b*) *Ligature of the common carotid above the omohyoid* (*seat of election*). *Indications :* for Injuries of the vessel : for hæmorrhage of the carotid and its branches, whether primary or secondary, permanent ligature should be avoided if possible, since cerebral affections, hemiplegia, &c., are likely to follow, and the common trunk should on no account be tied if ligature of the external carotid will suffice. As a temporary measure it is good practice to place a clamp on this vessel while searching for bleeding from its branches, also for operations on tumours of the skull or face where much hæmorrhage is likely. This vessel may also be tied as distal ligature for aneurysms at its origin and of the innominate, and for " pulsating exophthalmos " (*see* Retro-orbital Aneurysm, p. 31).

Operation. The patient lying as before, a three-inch incision is made along the anterior border of the sternomastoid with its centre opposite the

cricoid cartilage. The sternomastoid is retracted, the omohyoid found running across the carotid sheath, and is retracted inwards ; the descending branch of the hypoglossal is displaced and, with the jugular vein which overlaps the external part of the artery, retracted outwards. The sheath is opened and the needle passed from without inwards to avoid the vein, and the vessel is raised out of its bed to make quite sure that the vagus is not included in the ligature.

Ligature of the External Carotid. Relations. (*a*) In front : The sternomastoid, the lingual and facial veins, the hypoglossal nerve, and, higher up, the parotid gland, the digastric muscle, and the facial nerve.

(*b*) Internally : The hyoid bone, pharynx, ramus of the jaw, parotid gland.

(*c*) Externally : The internal carotid artery and jugular vein, sternomastoid.

(*d*) Behind : The stylopharyngeus and styloglossus muscles, the glossopharyngeal nerve, and parotid gland. The parotid gland is thus traversed by the upper part of the vessel, but the latter will only be tied in this position for injuries.

Collateral Circulation. Anastomoses with the opposite external carotid and with branches of the subclavian in the thyroid and posterior cervical regions, as mentioned for the common carotid.

Indications. Local injuries, aneurysm of the vessel, and cirsoid aneurysm of the scalp—as a preliminary measure to excising growths of the jaw, tonsil, palate, nasopharynx (unless a large dissection for removal of glands is being undertaken it will be far simpler in such cases to place a temporary clamp on the common trunk) ; as a palliative measure to inhibit growths in these situations (in such cases it will be better to excise the vessel and its branches or to inject two drams of boiling water into the vessel before tying, which will cause occlusion of all the branches).

Operation. An incision is made (the patient as before) along the anterior edge of the sternomastoid from the mastoid to the thyroid cartilage. The sternomastoid is retracted back and the posterior belly of the digastric forward. The lingual and facial veins crossing the artery may be much in the way, and should be divided between ligatures if troublesome. The hypoglossal nerve, crossing the vessel after hooking round the occipital artery, is a useful landmark. The jugular vein usually overlaps the artery and is displaced outward. The needle is passed from without inwards between the superior thyroid and lingual arteries, the latter being just above the cornu of the hyoid bone, the former just below. In most instances the facial, lingual, occipital, and ascending pharyngeal branches should be tied as well as the main vessel.

THE INTERNAL CAROTID. This vessel may be tied for local injury or aneurysm, but occasions for this operation are rare. The operation is on similar lines to that for exposing the external carotid, but this branch lies outside the former at first and later passes behind—which, together with the fact that it passes no branches at this situation, will serve to distinguish.

BRANCHES OF THE EXTERNAL CAROTID. (1) *The Superior Thyroid Artery.* This may be tied by a similar incision to that employed for tying the external carotid, but more commonly the thyroid branch alone is occluded in thyroidectomy, as described in Operations on the Thyroid Gland.

(2) *The Lingual.* This vessel will occasionally be tied for local injury, but more usually as a preliminary to removing the tongue, the pros and cons of which procedure are discussed under Operations on the Tongue.

The artery may be found either in its first part, just as it leaves the external carotid and before it passes under the hyoglossus, or in its second part as it lies under that muscle.

Landmark. The great cornu of the hyoid is opposite its origin. and the vessel lies a quarter of an inch above this for some distance.

(*a*) Ligature of the first part of the lingual.

This may be effected by a similar incision as that for exposing the external carotid, and this artery is distinguished from the facial and superior thyroid by being the first branch above the hyoid and by disappearing beneath the outer border of the hyoglossus muscle. (This operation will usually be done during a complete removal of lymphatic glands for cancer of the tongue, and the wide opening up of the neck will make its recognition easy.) ·

(*b*) Ligature of the lingual in its second part (place of election).

A curved incision is made and a flap of skin and platysma turned up, having its base from the angle of the jaw to the symphysis menti and its free border at the hyoid bone ; the submaxillary salivary gland is dislocated upwards, displaying underneath the mylohyoid muscle. The tendon of the digastric is pulled down and outward, rendering more obvious the hyoglossus passing under the outer edge of the mylohyoid and crossed by the hypoglossal nerve. The lingual artery lies beneath the hyoglossus in this situation between the hypoglossal nerve and the great cornu of the hyoid bone. The hypoglossus is divided across its fibres (horizontally) midway between these structures, and the lingual artery found underneath by a little exploring with an aneurysm-needle. If there is difficulty in finding the vessel the incision is enlarged and the first part sought as it arises from the external carotid, in which case the posterior belly of the digastric is hooked forwards.

(3) *Facial Artery.* This is seldom tied except as part of an extensive dissection to remove glands of the neck, as for cancer of the tongue, when it will be tied close to its origin from the external carotid. The vessel can be tied again as it reaches the face just in front of the anterior border of the masseter (ligature in both situations will be needed when the submaxillary gland is excised). In the latter situation on the face it can be readily exposed as an anatomical exercise by a short incision along the lower border of the jaw, the centre of which is over the anterior border of the masseter.

(4) *The Occipital Artery.* This may require ligature for a punctured wound or secondary hæmorrhage following an abscess of the occipital glands, and in two situations.

(*a*) At its origin by a similar incision as that for the external carotid, being known from its backward direction and that the hypoglossal nerve hooks round its origin.

(*b*) Behind the mastoid (the usual place for hæmorrhage). A two-inch incision is made back from the mastoid process towards the occipital protuberance dividing the fibres of the trapezius and splenius and finding the vessel as it comes to the posterior surface of the skull, lying in the groove on the lower surface of the mastoid process, deep to the posterior belly of the digastric.

(5) *The temporal artery* is tied for wounds and cirsoid aneurysm, and is found by making a vertical incision between the external auditory meatus and the condyle of the jaw. The vessel is quite superficial and close to the auriculo-temporal nerve, which must be separated before the ligature is applied.

(6) *The internal maxillary artery* may be tied if wounded by enlarging the wound and exploring, and in removal of the upper jaw. The finding of its important branch, the middle meningeal, is described in the section on Intracranial Hæmorrhage.

The Subclavian Artery. (1) The first part has been successfully tied on a few occasions, but the difficulty of this operation from the proximity of large veins, the vagus, phrenic and recurrent laryngeal nerves, to say nothing of the pleura and the number of branches given off from the main vessel close together, renders it a proceeding only to be attempted by surgeons of first-rate skill and large experience. The operation is on similar lines to that described for reaching the innominate, but after dividing the sternomastoid, probably removing the inner part of the clavicle and tracing the common carotid downwards, the dissection passes further out, avoiding the above-mentioned difficulties. Ligature of the innominate and common carotid is to be recommended in preference.

(2) *The Third Part of the Subclavian. Position and Relations.* The line of the vessel in the neck is from the sternoclavicular joint to the outer border of the first rib, arching up into the neck half an inch above the clavicle. The posterior scapular branch fairly often comes from this part, otherwise there are no branches.

Relations. (*a*) In front : The clavicle, subclavius muscle, the outer part of the sternomastoid, the external jugular vein, subclavian vein, and the suprascapular and posterior scapular arteries.

(*b*) Above : The cords of the brachial plexus.

(*c*) Below and behind is the first rib, while in emphysematous patients the bulging pleura may form a relation in this situation.

(*d*) Behind is the scalenus medius.

The main guide is the outer border of the scalenus anticus, leading to the scalene tubercle on the first rib, which is immediately in front of the vessel.

Collateral Circulation. The intercostal vessels and the internal mammary with the long thoracic, and the posterior and suprascapular with the scapular branches of the axillary.

Indications. This is the place of election for tying the vessel for local wounds, as proximal ligature for axillary aneurysm (sometimes temporary clamping may be possible, followed by an obliterative operation after Matas), as a preliminary to an interscapulo-thoracic amputation ; as a part of a distal ligature for innominate aneurysm.

Operation. The patient lies on the back with the head flexed to the opposite side and the shoulder well depressed. A three-inch incision is made half an inch above the middle of the clavicle. The outer border of the sternomastoid is defined and divided if extensive ; the external jugular vein is divided between ligatures if inconvenient. The suprascapular and posterior scapular arteries are retracted. The dissection is carried deeper and the outer edge of the scalenus anticus defined and cleaned down to the scalene tubercle on the first rib. The vessel will be felt pulsating behind the tubercle. The brachial plexus lies above and outside the vessel. The sheath is opened and the vessel cleared. Care is needed to avoid mistaking the lowest trunk of the plexus for the vessel. In the living subject the pulsation will render this unlikely, but on the cadaver the firmness of the nerve and the compressibility of the artery should prevent this very common error. The needle is passed from above to avoid the nerves and close to the vessel to avoid the pleura and the vein which lies in front and below. If the vessel is diseased at this point and unlikely to hold a ligature, the scalenus anticus may be partially divided and the ligature applied to the second part. In doing this the phrenic nerve lying in front of the scalenus anticus must be spared.

BRANCHES OF THE SUBCLAVIAN. The vertebral, internal mammary and inferior thyroid branch of the thyroid axis can be tied.

Indications. Local wounds of the vessels. It is important to find the bleeding-point with precision in wounds at the root of the neck, as the common carotid, vertebral, and inferior thyroid arteries are quite close together, and unless it is known which has been wounded it is speculative to ligature one of them.

(1) *The Vertebral Artery. Relations before entering the Vertebral Canal.* The vessel enters the canal in the transverse process of the sixth cervical vertebra, the projecting front of this (Chassaignac's tubercle) lying above the vessel. The scalenus anticus lies on the outer side, the longus coli on the inner side, while in front are the inferior thyroid artery and the internal jugular vein, with in addition on the left side the thoracic duct.

Indications. In aneurysm of the subclavian, in addition to tying the innominate and common carotid, or later if secondary hæmorrhage occurs. Where hæmorrhage or traumatic aneurysm occurs higher up in the canal as it traverses the transverse processes, it will be better to operate locally, removing portions of transverse processes and plugging the canal with the vessel.

Operation. The patient being in the dorsal position with the head turned to the opposite side, an incision is made along the lower half of the posterior border of the sternomastoid muscle. The latter is retracted inwards and the scalenus anticus defined ; the phrenic nerve lying on its anterior

surface is avoided. The space between the scalenus and longus coli is cleared (the ascending cervical branch of the thyroid axis lies on this) and the vessel found as it dips between these muscles to reach the foramen in the vertebra.

Chassaignac's tubercle above the artery forms a useful landmark. The jugular vein, inferior thyroid artery, and thoracic duct are displaced forward ; the pleura lies to the inner side. The needle is passed from within outwards.

(2) *The Inferior Thyroid Artery* (*see also* Affections of the Thyroid Gland). This vessel lies between the internal jugular vein and vertebral artery, just below Chassaignac's tubercle on the transverse process of the sixth cervical vertebra, and passes inward to the lower pole of the thyroid gland.

It may be tied through the incision mentioned for finding the vertebral artery, or by an incision along the anterior border of the lower half of the sternomastoid, retracting the sternohyoid and sternothyroid inwards and the great vessels outwards (after opening the carotid sheath). The vessel lies below the above-mentioned tubercle, and the recurrent laryngeal nerve must be avoided.

(3) *The Internal Mammary Artery.* This vessel lies half an inch outside the outer edge of the sternum, behind the cartilages of the ribs and inter-costal muscles but in front of the triangularis sterni and pleura. Ligature is indicated for wounds or when resecting a part of the thoracic wall, as in exploring the heart or removing advanced cancer of the breast ; in the latter instances it is readily picked up in the large wound. To find the vessel in a small wound or for exercise, a two-inch incision is made out from the edge of the sternum over an intercostal space and the intercostal muscles divided and retracted, exposing the vessel : both ends are secured. Where after division the vessel retracts, or if the space be narrow, there need be no hesitation in removing the cartilages above and below to allow of more room.

THE AXILLARY ARTERY. *Surface marking.* From the middle of the clavicle to the inner border of the coraco-brachialis muscle.

The vessel may be tied in its first or third part, *i.e.* above or below the crossing of the pectoralis minor.

Indications. As distal ligature for subclavian or proximal for brachial aneurysm ; and for wounds of the vessel, and occasionally for secondary hæmorrhage from brachial artery or palmar arch.

(1) The first part of the axillary artery.

Relations. (*a*) In front the pectoralis major and costo-coracoid membrane.

(*b*) Externally, the brachial plexus.

(*c*) Internally, the axillary vein.

(*d*) Behind, the wall of the thorax, serratus magnus, and nerve of Bell.

Operation. The patient lying on the back with the arm at the side, a four-inch incision inwards from the coracoid process, half an inch below the clavicle, divides the clavicular part of the pectoralis major. The costo-

coracoid membrane is divided and the acromio-thoracic branches of the artery followed down to the latter, which is cleaned and the needle passed from within outwards, avoiding the vein and the brachial plexus.

(2) The third part of the axillary artery (the more usual operation).
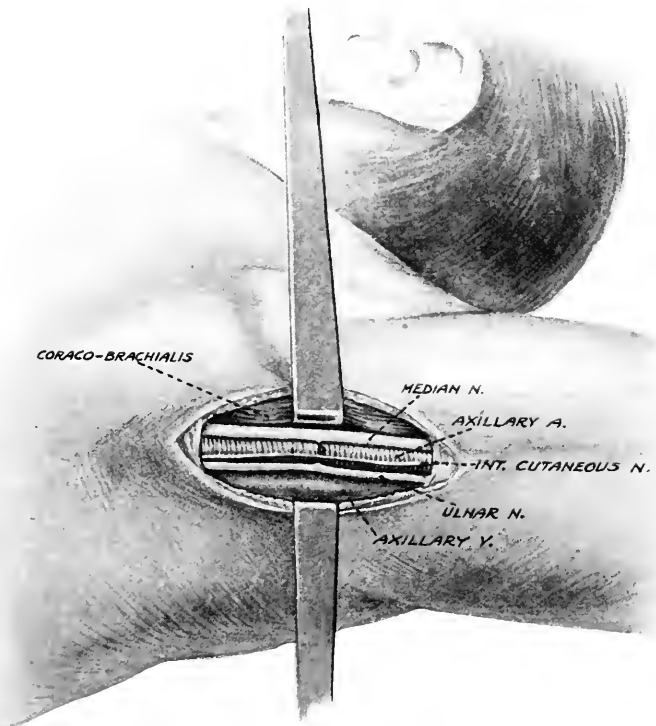
FIG. 18.   Exposure of the axillary artery (3rd part).

Relations.   (a) In front : The pectoralis and inner head of the median nerve, the vessel being subcutaneous below.

(b) External : The coraco-brachialis, the median, and musculo-cutaneous nerves.

(c) Internal : The axillary and basilic veins, ulnar and internal cutaneous nerves.

(d) Behind : The teres major, latissimus dorsi, subscapularis muscles, and musculo-spiral and circumflex nerves.

Operation.   The patient lies on the back with the arm abducted to a right angle and rotated outward.   A three-inch incision is made along the outer wall of the axilla at the inner border of the coraco-brachialis.   The median nerve is drawn out and the vein inward, and the needle passed from within outward.   Care must be taken to avoid tying by mistake the more superficial basilic vein which has thick walls, when operating on the cadaver. The relations of the surrounding nerves will prevent this error.   The ligature may be above or below the circumflex and subscapular branches, according to the requirements of the case.

Collateral Circulation. For ligature in the first part this will be the same as for the third part of the subclavian. When the third part is tied, if below the subscapular artery, there is the anastomosis between the posterior circumflex, acromio-thoracic, and subscapular; if above the subscapular, between the circumflex and subscapular on the one side and the suprascapular and posterior scapular on the other.

THE BRACHIAL ARTERY. *Line.* From the inner border of the coraco-brachialis to the point midway between the condyles of the humerus, in front of the elbow-joint.

Indications. Wounds of the vessel, secondary hæmorrhage of its branches, arterio-venous communications, aneurysms.

Collateral Circulation. The superior and inferior profunda branches with the recurrent branches of the radial and ulnar about the elbow. The vessel may be tied in the middle of the arm or at the elbow.

(1) *In the Middle of the Arm.* The arm is abducted and rotated outwards. A two-inch incision is made along the inner border of the biceps, which is retracted outwards; the basilic vein is avoided and the artery found crossed by the median nerve from without inwards.

(2) *At the Elbow.* The vessel is exposed by incision along the inner border of the biceps tendon, the bicipital fascia being divided. The vessel lies immediately to the inner side of the tendon, the median nerve lying some distance inwards.

THE RADIAL AND ULNAR ARTERIES. These may be tied for primary or secondary hæmorrhage. For secondary hæmorrhage lower down, *e.g.* from the palmar arch, ligature of the brachial or third part of the axillary is far more efficacious. Systematic ligature of these vessels, except when exploring wounds, hardly comes into practical surgery, and only a few of the more salient features of these operations will be mentioned here.

MEDIAN N.

BASILIC V.

BRACHIAL A.

ULNAR N.

RADIAL A.

ULNAR A.

SUPERFICIAL PALMAR ARCH
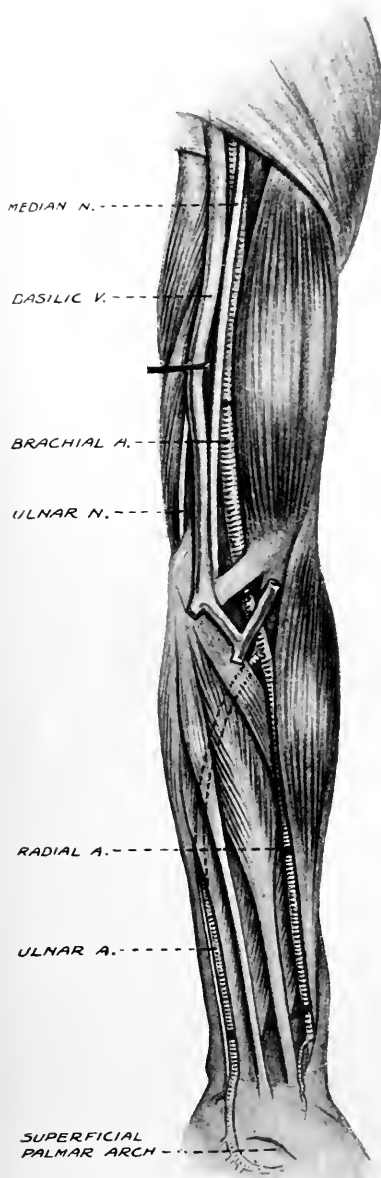
FIG. 19. Surgical anatomy of the brachial, radial, and ulnar arteries, showing where ligatures may be applied.

The Radial Artery. *Line.* From the lower end of the brachial to the point between the tendon of the flexor carpi radialis and the styloid process of the radius.

Relations. The vessel lies under the inner border of the supinator longus in the upper two-thirds of its course, but below this is subcutaneous. The radial nerve is to the outer side in the whole course, being separated above by an interval, lying close to the vessel in the middle part, and finally passing to the back of the wrist proximal to the radial styloid. The vessel is readily found in any part of its course by an incision along the radial border of the supinator longus. At its lower end as it passes under the long extensor tendons of the thumb it may be found in the " snuff-box " between the long and short extensors of the thumb, lying subcutaneously on the scaphoid.

The Ulnar Artery. *Line.* In its lower two-thirds it is represented by a line from the radial side of the pisiform bone to the mid-point between the internal condyle of the humerus and the olecranon. The upper part of the vessel lies between the upper end of the above line and the mid-point of the front of the elbow.

Relations. Close to the wrist the vessel is subcutaneous, and is reached by an incision to the radial side of the flexor carpi ulnaris, the ulnar nerve lying on the ulnar side of the vessel.

In the middle of the forearm the vessel is found by an incision over the line of its superficial marking. The flexor carpi ulnaris and flexor sublimis are separated, or, as the line of cleavage is often difficult to find, the muscles should be split longitudinally in the above line till the flexor profundus is reached. Having reached this level, search is made in the ulnar direction, when the vessel will usually be found, the ulnar nerve lying to its inner (ulnar) side. If the vessel be not found in this direction search is made towards the radius, and where failure is again encountered there is probably a high division of the brachial (a common anomaly),

Fig. 20. Incisions for exposing: *a*, brachial artery in the arm; *b*, brachial artery at the elbow; *c, e,* radial artery; *d, f,* ulnar artery.

and the ulnar artery then lies subcutaneously and can be found under the skin by searching in the line of the vessel.

PALMAR ARCHES. The line of the superficial arch is level with the web of the thumb, and it lies superficial to the tendons. The deep arch lies a quarter of an inch proximal to this and beneath the tendons. If these points be remembered the vessels are found without difficulty.

LIGATURE OF THE ABDOMINAL AORTA. This vessel has not been tied with complete success up to date. But the partial successes resulting lead

one to hope for better results in the future and not to condemn the operation as unjustifiable.

The vessel is tied between the bifurcation and the lowest visceral branch (the inferior mesenteric), this portion being an inch and a half long.

Position and Relations. The bifurcation of the aorta lies half an inch below and to the left of the umbilicus on the fourth lumbar vertebra. In front is the peritoneum, to the right the vena cava, behind the lumbar veins, and around is the sympathetic plexus.

Collateral Circulation. The internal mammary with the deep epigastric, the lumbar vessels with the gluteal and sciatic branches of the internal iliac, and the inferior mesenteric with the internal pudic.

Indications. Aneurysm of the common iliac high up, possibly involving the bifurcation, especially where other measures such as acupuncture and wiring fail or secondary hæmorrhage results.

Operation. The trans-peritoneal route is generally advisable. The patient being in the Trendelenberg position, laparotomy by a four-inch paramedial incision is p rformed with the centre at the umbilicus ; the intestines are packed off and the peritoneum over the left side of the vessel incised and cleared off—the latter together with the sympathetic plexus, which should on no account be included in the ligature. The needle is passed from right to left and the ligature tied with the stay-knot. The vessel can also be reached by a muscle-splitting incision in the left iliac fossa as for exposure of the ureter (owing to the presence of the vena cava this will be difficult on the right side) ; as the peritoneum is intact there is less difficulty with the intestines, which seem to have been the main source of trouble in this operation.

THE ILIAC ARTERIES (common, external, internal). *Line.* From the point of bifurcation of the aorta the iliac vessels run to the point midway between the anterior superior spine and the pubic symphysis ; the upper third of this line represents the common, the lower two-thirds the external, iliac—the origin of the internal branch being at the junction of the other two.

Relations. The vessels are covered with peritoneum on their anterior surfaces. The ureter crosses the bifurcation of the common iliac on each side. The sigmoid, mesocolon, and inferior mesenteric artery cross the common iliac on the left side. The psoas lies to the outer side of the common and external iliacs on each side. The vein lies to the inner side of the external iliac arteries and the left common iliac, but the common veins as they unite cross behind the right common artery, passing to its right, so that both right and left common veins and their junction in the inferior vena cava lie behind and to the right of the right common iliac artery.

Indications. The common iliac is tied for wounds, secondary hæmorrhage below, aneurysm of the vessel, temporarily before amputation of the hip-joint. The internal iliac is tied for secondary hæmorrhage and aneurysm of the gluteal and sciatic arteries, sometimes before operations on the

pelvis, such as excision of the rectum. The external iliac, for secondary hæmorrhage lower down or aneurysm of the femoral high up.

Operation. All three vessels may be approached through the same incision, which may be a laparotomy or a muscle-splitting incision in the iliac fossa, on the requisite side, the peritoneum being stripped from the iliac fossa. The extra-peritoneal route is to be recommended unless the tissues are much matted together, as by a large aneurysm, when there will be considerable disturbance of anatomical relations, and the larger exposure by a laparotomy will make for more accurate and speedy operating. The muscle-splitting operation has the advantage that there is less trouble with intestines, and on the left side the sigmoid, mesocolon, and on both sides the ureter, is lifted up with the stripped peritoneum, and so are out of the way. The muscle-splitting incision separates the external and internal oblique and transversalis along their fibres as for appendicectomy, but is made on a larger scale : the peritoneum is stripped from the iliac fossa till the pelvic brim is reached, on which lie the iliac vessels. The bifurcation of the vessels can be made out on the sacro-iliac synchondrosis and the vessel freed by blunt dissection (the needle passed from within to avoid the vein) and tied. If the parts are obscured the peritoneum may be opened and intestines packed off. It is quite easy through such a muscle-splitting incision to expose the whole length of the common and external iliac. The internal iliac is more readily reached by paramedial laparotomy. These methods render unnecessary the classic procedures of Cooper or Abernethy.

BRANCHES OF THE INTERNAL ILIAC ARTERY (gluteal, sciatic and pudic). These vessels are seldom tied except for wounds. Aneurysms of the sciatic and gluteal arteries are better treated by ligature of the internal iliac.

(1) *The Gluteal Artery.* This vessel emerges from the pelvis through the upper part of the great sciatic notch above the pyriformis, the point of exit being located on the surface at the junction of the inner and middle thirds of the line joining the posterior superior iliac spine with the tip of the great trochanter. To reach the vessel the fibres of the gluteus maximus are split by an incision having its centre at this point and are retracted.

(2) *The Sciatic and Pudic Arteries* emerge from the lower part of the sciatic notch below the pyriformis, the point being marked by the junction of the middle and lower thirds of the line joining the posterior superior iliac spine with the tuber ischii. By splitting the fibres of the gluteus maximus over this point the vessels will be found below the pyriformis to the inner side of the great sciatic nerve : the pudic is innermost and ties on the ischial spine.

THE COMMON FEMORAL ARTERY. This artery is rarely tied as the collateral circulation is poor and gangrene is more likely than after ligature of the external iliac or superficial femoral ; the main indication is a wound of the vessel.

Line. The femoral artery is indicated by a line joining the mid-point between the symphysis pubis and the anterior superior spine with the adductor tubercle (the thigh being slightly flexed, abducted, and everted).

The upper inch and a half represent the common trunk, the lower portion the superficial femoral. The common femoral is quite superficial and
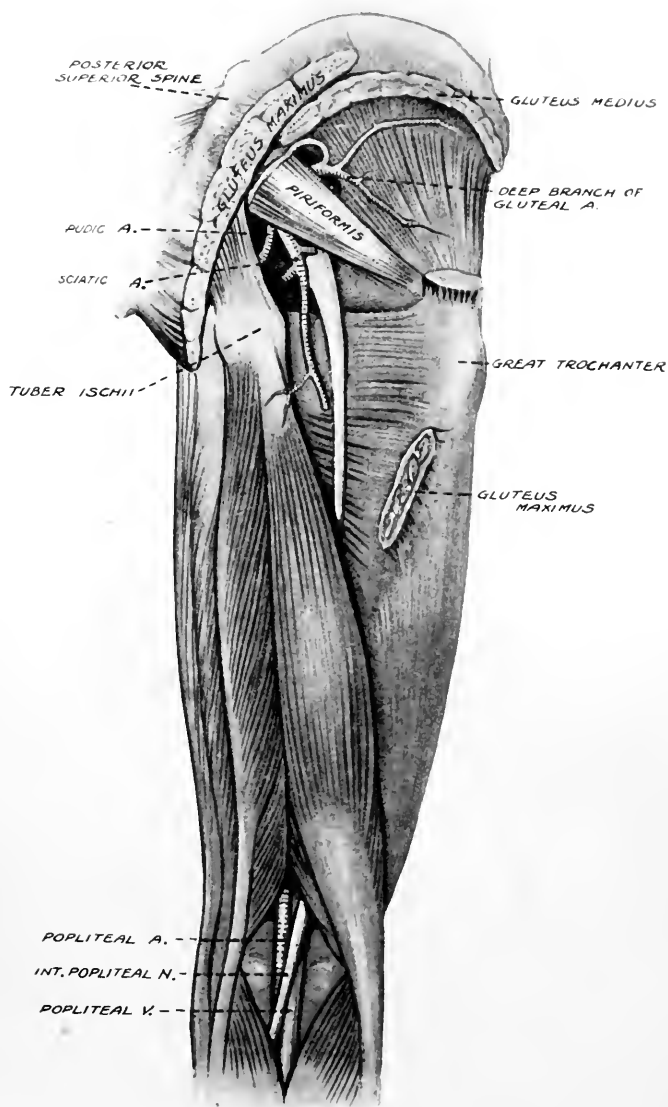
FIG. 20A. Surgical anatomy of the gluteal, sciatic, pudic and popliteal arteries.

reached by a three-inch incision in the line of the vessel, the centre of which is at Poupart's ligament (if commenced at Poupart's ligament the middle of the incision will lie over the superficial femoral).

The vein lies to the inner side, while the small genito-crural nerve and

ilio-psoas muscle are on the outer side, the anterio-crural nerve being about half an inch further out. The needle is passed from the inner side. In case of hæmorrhage in this region it is essential to find the exact point of injury, and if this be at the bifurcation of the common femoral it will be necessary, as we found in one case, to tie the common trunk and the superficial and deep branches before bleeding ceases.

THE SUPERFICIAL FEMORAL ARTERY. The line is as for the common trunk.

Relations. The sartorius crosses in front of the lower part of the vessel, and the fascia covering the roof of Hunter's canal is also in front. To the outer side are the vastus internus, the nerve to this muscle, and the long saphenous nerve. To the inner side are the adductor longus and magnus. Behind are the superficial femoral vein, the profunda femoral artery and vein, separated lower by the adductor longus.

Collateral Circulation. The perforating branches of the profunda and the branches of the external circumflex with the muscular branches of the superficial femoral and the articular branches of the popliteal.

Indications. For wounds or secondary hæmorrhage lower down : This was the main situation for the application of proximal ligature at a distance (Hunter) for popliteal aneurysm, but Matas's operation is supplanting the classic method. The vessel may be tied in Scarpa's triangle or Hunter's canal.

(a) *Ligature in Scarpa's Triangle.* The thigh being abducted and everted, a four-inch incision is made in the line of the vessel a hand's breadth below Poupart's ligament. The inner edge of the sartorius is found and retracted outward, exposing the vessel in its sheath ; the latter is opened and the vessel cleared, avoiding the vein which lies behind and the

FIG. 21.   Incisions for exposing : A, Gluteal artery. B, Sciatic artery. C, Popliteal artery.

long saphenous nerve which is on the inner side : the needle is passed from the inner side.

(b) *Ligature in Hunter's Canal.* The limb being in the above-mentioned position, a four-inch incision is made in the line of the vessel with its centre in the middle of the thigh ; the outer border of the sartorius is found and retracted inwards, the fascia roofing Hunter's canal (between the vastus internus and adductor magnus) is opened, and the vessel exposed. The saphenous nerve crosses the vessel from within outwards and the vein lies close behind.

THE POPLITEAL ARTERY. The line is from the lower end of the femoral, practically along the mid-line of the popliteal space.

Relations. In front, the femur, the posterior ligament of the knee-joint, and popliteus muscle; externally, the biceps and outer head of the gastrocnemius; internally, the semi-membranosus and inner head of the gastrocnemius; behind lie the external saphenous vein and the lower end of the small sciatic nerve, the internal popliteal nerve and the popliteal vein.

Collateral Circulation. The descending branch of the external circumflex and the anastomotica magna unite with the articular branches of the popliteal and the recurrent tibial.

This vessel is but seldom tied, though this is done for wounds and ruptures of the vessel or as proximal ligature should Matas's method be deemed too difficult. The vessel may be exposed from the inner aspect of the lower part of the thigh or from the popliteal space behind.

(a) *In the Thigh.* The thigh being flexed and well everted, a four-inch incision is made over the lower part of the tendon of the adductor magnus, the sartorius and hamstrings retracted backwards, and the dissection passes behind the tendon of the adductor magnus, the artery being found separated from the lower end of the femur by a pad of fat.

(b) *In the Popliteal Space.* The patient lies on the face. The upper part of the vessel is reached by incision on the outer side of the semi-membranosus, trending down to the centre of the popliteal space. The lower part of the

Fig. 22. Surgical anatomy of the arteries of the thigh and leg. The tendon of the adductor magnus is pulled forward to show the upper part of the popliteal artery: the inner head of the soleus is split to show the posterior tibial artery.

artery is reached by a median, longitudinal incision in the mid-line between the heads of the gastrocnemius. The internal popliteal nerve and the popliteal vein will need retraction, and in addition in the lower part the external saphenous vein must be retracted or divided.

THE ANTERIOR TIBIAL ARTERY. This is seldom necessary except for wounds or traumatic aneurysms. The line joins the mid-point between the outer tuberosity of the tibia and head of the fibula with the mid-malleolar point in front of the ankle-joint. The vessel may be tied at any point in this line.

Relations. The tibialis anticus lies on the inner side all the way down. On the outer side the extensor longus digitorum is in immediate relation above, but lower down the extensor hallucis intervenes and crosses to the inner side of the vessel close above the ankle. The anterior tibial nerve lies on the outer side all the distance.

(a) *Ligature of the Anterior Tibial high up.* A four-inch incision is made in the line of the vessel. The main difficulty next is in finding the right intermuscular plane, which intervenes between the tibialis anticus and the extensor digitorum and extensor hallucis (lower), as it is very easy to choose that between the peronei and the anterior tibial muscles by mistake. The best plan (Dean) is to reflect flaps of the fascia covering the muscles and search outward and inward till small arteries are found coming up through an intermuscular space. This will be the requisite place to dissect deeper, and the vessel is readily found, the needle being passed from without inwards.

(b) In the lower part of the leg the incision lies between the tendons of the tibialis anticus and the extensor hallucis ; the latter is retracted outwards and the vessel easily found, being then superficial.

THE DORSALIS PEDIS. This vessel runs from the lower end of the anterior tibial to the first interosseous space, with the extensor hallucis on its inner side and the innermost tendon of the extensor brevis digitorum, and the nerve on its outer aspect. The vessel is quite superficial, and readily found by an incision along the line mentioned between those tendons.

FIG. 23. Incision for ligaturing. A, The common femoral. B, The superficial femoral in Scarpa's triangle. C, The superficial femoral in Hunter's canal. D, The upper part of the popliteal. E, The upper posterior tibial. F, The lower posterior tibial.

THE POSTERIOR TIBIAL ARTERY. The line is from the middle of the lower part of the popliteal space to a point midway between the internal malleolus and the tendo Achillis.

Relations. In its upper part the vessel lies deep to the gastrocnemius and soleus upon the tibialis posticus and flexor longus digitorum. The posterior tibial nerve crosses the artery from within outwards in the

upper part of its course and lies on its outer aspect for the rest of the distance.

Operation. The thigh is flexed and everted, the knee flexed. The vessel may be tied in any part of its course.

(*a*) In the upper part a four-inch incision is made half an inch behind the inner border of the tibia, the gastrocnemius retracted back, and the soleus divided in the line of incision, including its deep fascial portion, and retracted
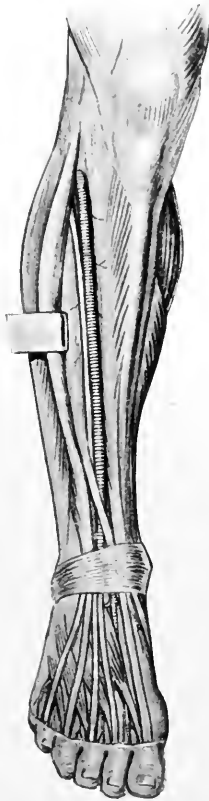
Fig. 24. Surgical anatomy of the anterior tibial and dorsalis pedis arteries.
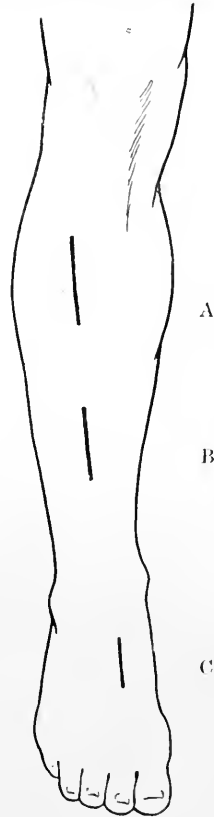
Fig. 25. A and B, Incisions for exposing the anterior tibial artery. C, Incision for exposing the dorsalis pedis.

outwards. The vessels are found on dissecting outwards from this line, the nerve being on their outer side.

(*b*) In the lower part of the leg the vessel is readily found by an incision between the inner border of the tibia and the insertion of the soleus into the tendo Achillis lying on the flexor longus digitorum.

(*c*) At the internal malleolus the artery is exposed by an incision a finger's breadth behind the malleolus. The internal annular ligament is divided and the vessel found between the tendons of the tibialis posticus and flexor longus digitorum in front and the nerve and tendon of the flexor longus hallucis behind.

The Peroneal Artery. This vessel may be found by an incision along the outer border of the fibula in its middle, dividing the outer head of the soleus, retracting the latter, and raising the flexor longus hallucis from the bone. The artery lies in a groove on the deep surface of the muscle close against the bone.

Operations on Veins. The internal jugular vein may be reached by an incision along the anterior border of the sternomastoid similar to that for finding the external carotid artery, to which the vein lies external and posterior. The facial and lingual veins opening into the jugular vein assist in finding the latter : where the vein is widely thrombosed the incision may be carried down to the clavicle and the vein tied below the thrombus. Its branches—the lingual, facial, and possibly superior thyroid—should be tied if opening into the thrombosed section of the vessel.

Varicose Veins. The principal methods of removing these have been enumerated. In slighter cases there may be some difficulty in seeing the position of the veins when the patient is recumbent. This may be obviated by placing a tourniquet round the limb near the groin, but only pulling it moderately tight so as to occlude the superficial veins and make them more prominent. Another plan is to mark out the veins with solution of silver nitrate (5 per cent.) while the patient is standing up and then brushing over a solution of pyrogallic acid, which renders the mark of reduced silver very clear.

SURGERY OF THE LYMPHATIC SYSTEM

General : Injuries : Division of the Thoracic Duct : Lymphangitis : Acute,
Chronic : Lymphatic Obstruction : Elephantiasis : New Growths : Nævi :
Hygromas : Acute Lymphadenitis : Operations : Chronic Lymphadenitis :
Tuberculosis : Excision of Tuberculous Glands : Syphilis : Lymphadenoma :
Secondary Tumours of Lymph-Nodes.

General. The lymphatic system serves to drain the superfluous nutrient
fluid from the tissues back into the veins, and also by the presence of the
lymph-nodes to arrest the progress of certain noxious objects which may
pass along in its stream. The lymph drainage system consists of lymph or
intercellular spaces whence the lymph proceeds into the lymph capillaries
and so to the lymphatic trunks. These resemble veins in structure but have
a thinner and weaker wall and a far greater number of valves. The
lymphatic vessels join the veins through the thoracic duct, the right
lymphatic duct, by other communications in the thorax and possibly
elsewhere.

At intervals the lymph-vessels open out into lymph-glands or nodes
as rivers may expand into lakes, the lumen forming up again on the far
side of the nodes. These nodes consist of a basis of connective tissue and
branching cells filled with masses of small round cells or " lymphocytes,"
between and around which are the lymph spaces formed by breaking up of
the lymphatics. The nodes act as filters for catching substance passing
along in the lymph-stream, whether the latter are inert matter, as powdered
carbon, or infective, such as bacteria or the cells of malignant tumours.
This process of filtration is one of the reasons why an accurate knowledge
of the lymphatic drainage is of such value in surgery, since only in this
way can we locate the possible magnitude of infection far beyond its macro-
scopic limits and make our operative attempts accordingly. In addition
the lymphatics come into notice from being blocked, causing peripheral
changes such as œdema, &c., while primary new growths are not uncommon
in these tissues.

Anatomy. Lymph-nodes are aggregated together in certain places,
especially where there is a union of lymph channels, so that a description
of their distribution and liability to disease will be helpful in diagnosis.

Head and Neck. The occipital glands are situated below the superior
curved line of the occiput, over the insertion of the trapezius, and drain the
back of the scalp. These glands are commonly affected by pyogenic con-

ditions of the scalp, usually initiated by pediculi. Hence abscesses are commonly found here in young women and girls with dirty heads.

The mastoid glands are situated over and behind the mastoid and origin of sternomastoid, draining the auricle and side of the scalp. These glands are commonly affected secondarily to suppurative lesions of the scalp, often in small children, and the swelling is distinguished from mastoiditis by being more posterior and by its not pushing the ear downwards, though the latter may be displaced forwards.

The parotid and præauricular glands drain the side of the scalp, forehead, and eyelids. These glands are most usually enlarged from tuberculosis. The buccal glands, close to the point where the duct of Stenson pierces the cheek, are occasionally enlarged, and account for some chronic abscesses of the cheek.

The facial glands lie on the face at the point where the facial artery crosses the lower jaw, and are sometimes enlarged from tuberculosis.

The submaxillary lymph-glands lie below the jaw in the substance and around the salivary gland of the same name. They drain the lower and upper lips, the greater part of the tongue, the floor of the mouth, and the gums. They are enlarged in tuberculosis, lingual cancer, and in acute infections (Ludwig's angina).

The submental glands lie between the anterior bellies of the digastrics in the middle line, above the hyoid bone, and drain the lower lip and tip of the tongue. They are affected in tuberculosis, cancer of the anterior part of the tongue, and sometimes in cancer of the lip.

The external jugular glands lie along the external jugular vein and drain the lower part of the pinna and mastoid, and are enlarged in tubercle and pyogenic infections of the external ear. The above glands are superficial and receive drainage direct from the periphery, and in turn drain, by their efferent lymph-channels, into the deep cervical glands which lie along the jugular vein under the sternomastoid.

The deep cervical glands receive lymph from the above superficial groups, and also some primary efferents direct from the tissues ; they are arranged in two chains, an external or posterior, which lies under the posterior border of the sternomastoid and around the origin of the cervical plexus of nerves, and an internal or anterior, which extends from the basis of the cranium to the clavicle in close relation to the internal jugular vein.

The *external deep cervical glands* receive drainage from the occipital, mastoid and external jugular groups, as well as from the scalp and neck. They are often affected in tuberculosis, sometimes in pyogenic disease, fairly often in secondary syphilis, and can be felt projecting behind the sternomastoid.

The *internal deep cervical glands* receive drainage from the submaxillary, submental, parotid, facial, buccal groups, as well as from the tonsil, palate, back of the tongue, pharynx, larynx, upper œsophagus, and thyroid. One of these glands at the angle of the jaw, behind the posterior belly of the

digastric and between the common facial and internal jugular veins, is so commonly enlarged in affections of the tonsil as to receive the name of the " tonsillar gland."

Outlying parts of the internal cervical chain lie behind the pharynx (retro-pharyngeal glands), draining the pharynx and nasal cavities and the base of the skull. They lie in front of the prevertebral fascia, and when breaking down from tuberculosis give rise to one form of " retro-pharyngeal abscess." The efferent lymphatics from the internal cervical chains (jugular lymphatic trunk) join with the subclavian trunk on the right side to form the right lymphatic duct or run direct into the innominate vein ; on the left side the efferent joins the thoracic duct or runs into the jugular vein. The inner part of the deep cervical glands are affected very commonly in tuberculosis, less often in acute pyogenic affections, and often in cancer of the tongue, palate, tonsil, pharynx, œsophagus, thyroid, &c.

The *supraclavicular glands* lie in the lower part of the posterior triangle of the neck, above the clavicle. They receive drainage from the external deep cervical chain, and also afferents from the neck, upper chest-wall, and some of the highest axillary glands. Sometimes the lymphatics accompanying the cephalic vein end here instead of entering the subclavian group of axillary glands. The supraclavicular glands drain into the jugular lymphatic trunk and are affected in cancer of the breast (late), and those of the left side sometimes in cancer of the stomach, while they are fairly commonly affected with tuberculosis and less often with acute pyogenic infection.

THE UPPER EXTERMITY. The epitrochlear gland is fairly constant and situated just above the internal condyle of the humerus ; it receives drainage from the ulnar side of the hand and forearm, and is often enlarged on both sides in secondary syphilis. The antecubital glands in the fold of the elbow are often absent.

The cephalic glands are found in the space between the deltoid and pectoralis major along the cephalic vein, and receive drainage from the radial side of the hand and forearm ; they drain into the upper axillary glands, and may be affected in whitlow of the thumb.

THE AXILLARY GLANDS. These are grouped in three main sets :

(*a*) Along the outer edge of the pectoralis minor, draining the breast and chest-wall.

(*b*) Along the subscapular vessels, draining the posterior, upper part of the trunk ; this group may drain into the central group or into the subclavian glands.

(*c*) The central group lies along the axillary vein, and receives lymphatics from the arm and the two previous groups.

The *subclavian group* is a continuation upwards of the central axillary group along the axillary and subclavian vein. They receive the drainage from the other axillary groups, from the upper and inner part of the breast direct, and from the cephalic glands. The efferents from these glands form the subclavian lymphatic trunk, which joins the thoracic duct on the

left but on the right side joins the right lymphatic duct or the innominate vein ; some efferents join the supraclavicular glands.

The axillary glands are affected in tubercle, acute pyogenic infection, and cancer of the breast.

THE LOWER LIMB. The popliteal glands lie in the popliteal space beneath the deep fascia next the popliteal vein. They receive drainage from the outer part of the foot and leg : they are seldom affected except by acute pyogenic infection, causing a painful swelling with marked flexion of the knee.

The *inguinal glands* are arranged in two groups, the vertical and oblique, the former being again divided into superficial and deep, the latter being only superficial. The oblique set lies just below Poupart's ligament.

The outer part of the oblique set drains the outer part of the thigh, the buttock, and outer part of the abdominal wall below the umbilicus. The inner part of the oblique glands drains the middle part of the lower abdominal wall, the skin of the external genitals, including the lower vagina, the scrotum, perineum, and lower part of the anal canal. These glands all drain into the deep glands of the vertical set.

The vertical set consists of a superficial group along the upper part of the saphenous vein ; they receive drainage from the inner part of the thigh, leg and foot, and in turn discharge their efferents into the deep set.

The deep part of the vertical set is situated along the inner side of the common femoral vein, and receives drainage from the other inguinal glands and the deep vessels of the thigh. The uppermost member of this vertical set lies in the femoral ring (Cloquet), and when enlarged resembles an irreducible femoral hernia. The inguinal glands drain into the group along the external iliac vessels. Any of these glands may be the seat of pyogenic infection due to sores on legs, penis, anus, &c. : tuberculosis is less common than in the neck and axilla, but is by no means rare. The inner oblique glands are most affected in penile chancres and cancer of the penis and scrotum.

The lymphatics of the trunk are considered under the surgery of special regions, especially of the Abdomen.

INJURIES OF LYMPHATICS. Incised wounds of lymphatics usually heal readily by clotting of lymph in their interior and cicatrization. Where large lymph channels are divided in the axilla, neck or groin, a lymphatic fistula sometimes develops, but these usually heal after the collateral lymph-circulation has developed. As the result of extensive removal of glands and lymph-trunks the lymph drainage may be impaired and lymphatic œdema result, though this is not common.

Rupture and Division of the Thoracic Duct. When this large lymphatic trunk is divided, as in wounds and operations about the root of the neck on the left side, the lesion is usually obvious owing to the escape of milky fluid (chyle) from a small vessel resembling a vein. Where found at operation an attempt should be made to restore the continuity with a few sutures of the finest silk soaked in vaseline, or to implant the duct into a neigh-

bouring vein. Should this fail the duct may be tied. This will as a rule be satisfactory, as there are nearly always other openings of the duct into veins besides the main one into the left internal jugular. Recovery is the rule in these cases. Subcutaneous rupture may occur after crushes of the neck, chest or upper abdomen, the chyle escaping into the posterior mediastinum, pleura, retro-peritoneal tissues, or peritoneum. The physical signs suggest the presence of a tumour or fluid in one of the above-mentioned situations, while the patient becomes emaciated. Short of exploration with needle or knife, accurate diagnosis is seldom possible.

INFLAMMATIONS AND INFECTIONS OF THE LYMPHATIC VESSELS (lymphangitis). Both acute and chronic varieties are found.

Acute Lymphangitis. This is caused by infection with pyogenic organisms, of which the streptococcus is the most usual. The changes in the lymphatics are those of inflammation elsewhere, hyperæmia, proliferation of the inner coat, and thrombosis of the contents of the vessel : the clot may break down and suppurate with formation of abscess in the lymphatic channel, as in phlebitis, with which this condition has much in common. More usually infective organisms traverse the course of a lymphatic without producing any obvious inflammation of the latter, but are arrested in the next group of lymph-nodes, which become inflamed and tender.

Signs. Following some breach in the epidermal covering, often of minor character, such as pricks, stings, blisters from friction, there will be found a red line spreading along the limb to the nearest group of lymph-glands—the skin along this line being red, tender, but with no swelling palpable. Local swelling is slight unless many trunks are involved, when there may be some œdema. This description applies rather to affection of the larger trunks. Where the smaller vessels are affected the skin becomes red, tender and œdematous, and the condition is practically that of " cellulitis." There is generally a moderate degree of fever, considerable malaise, sometimes an initial rigor, while the glands to which the inflamed lymphatic leads are swollen and tender. Later an abscess may form along the course of the lymphatic, but more usually in the glands into which it drains. (*See* Cellulitis, vol. i.)

Results. Most often the condition clears up completely, but abscess may result or (especially if repeated attacks occur) the lymphatics may become blocked by cicatrization and œdema of the part below the site of obstruction result, ending in the condition known as " elephantiasis."

Treatment. The initial focus must be dealt with, cleaning off crusts of dried pus, opening abscesses or areas of cellulitis, and applying moist antiseptic dressings. Local suppuration in the course of lymphatics will need opening like other abscesses. Œdema occurring later will be treated by bandaging, massage, possibly by " lymphangeioplasty." (*See le'cw.*)

Chronic Lymphangitis. In this condition there are thickening and fibrosis of the vessels, leading to their obliteration, which may be due to the result of past acute inflammation, as already mentioned, or caused by tuberculous, syphilitic, filarial, or cancerous infection.

(a) *Tuberculous Lymphangitis.* This is not very common on the surface of the body, but occasionally thickened cords are found, usually in the arms, leading from some tuberculous focus such as a dactylitis or " anatomical wart " to the axillary glands, which are enlarged and possibly caseating. Caseation and the formation of cold abscesses may occur along the course of such thickened lymphatics. Tuberculous lymphangitis is seen more usually in the mesentery when a tuberculous ulcer is present in the intestine, and the lymphatics are beautifully marked out as if by injection, being thick, firm white cords leading from the ulcer to the enlarged mesenteric glands, showing very clearly the manner in which the infection spreads.

Treatment. The primary focus should be treated, usually by excision, in which case the infected vessels will mostly heal by fibrosis, but should they already be caseating and suppurating they must be excised or treated as a cold abscess. Where the initial focus, lymphatics, and collection of infected glands can be removed, as in the case of tuberculous ulcer of the intestine with secondary tuberculous mesenteric glands, the whole area of infection should be removed, including gut, mesentery and glands, followed by anastomosis of the intestine.

(b) *Syphilitic lymphangitis* is found principally in primary syphilis in the form of firm cords on the dorsum of the penis, leading from a chancre to the enlarged inguinal glands (bubo), and may help in the diagnosis, but no treatment other than specific is needed. In tertiary syphilis the lymphatics may be involved in a gummatous and fibrosing affection leading to their obliteration, followed by solid œdema of the part drained, especially in the lips, sometimes in the legs.

(c) *Filarial lymphangitis* is due to blocking of the lymphatics of the lower limbs and scrotum with filaria worms, which act as foreign bodies and set up fibrosis and obliteration of the channels, with resulting elephantiasis (*see* Scrotum).

(d) *Malignant lymphangitis* is caused by the spread of emboli from malignant growths (usually cancers) along lymphatic channels. The resulting lymphangitis is largely protective (Handley), the cicatrisation destroying the cancer cells ; as a result the lymphatics are blocked and elephantiasis may result.

LYMPHATIC OBSTRUCTION (*elephantiasis, lymphangiectasis,* &c.). As a result of obstruction to lymphatics we find :

(a) Œdema of a solid nature, the swollen part pitting but slightly on pressure, and quite different, therefore, from the œdema due to blocking of a vein, where the finger sinks readily into the boggy tissue, leaving a deep pit. A common variety of this condition is the well-known " white leg " of the obstetrician, following the puerperium and supposed to be due to mild infection spreading from the uterus to the pelvic lymph-trunks, and so obstructing the lymphatic return from the leg. The condition is usually transient and for the most part disappears, leaving, perhaps, some permanent thickening of the subcutaneous tissues.

(b) In cases where the lymphatic obstruction is more pronounced or recurrent the lymph channels below the obstruction become dilated and varicose, expanding on the skin into blebs and bullæ containing lymph, which burst, discharging lymph (lymphorrhœa). This discharge irritates the skin and causes eczema and inflammation with thickening. In addition the tissues around the dilated lymphatics become hypertrophic from the formation of loose fibrous tissue, ultimately assuming enormous proportions (elephantiasis), the skin over the swollen and shapeless part being rough, brawny, warty, and, owing to the constant discharge of lymph, often ulcerated and inflamed.

Such a condition is found in a minor degree in the thickened lips following tuberculous and pyogenic ulceration about the mouth, sometimes in tertiary syphilis. Blocking of the axillary lymphatic trunks with cancerous emboli from the breast may give rise to very marked elephantiasis of the arm, but the most advanced examples are those of the scrotum and legs occurring in the tropics, and due to

FIG. 26. Lymphatic obstruction in right axilla, causing solid œdema of right arm (early elephantiasis) due to a recurrence of cancer of the breast in the axillary glands.

filariasis. This condition is to be distinguished from the congenital elephantoid condition found in the tongue, lips and limbs (macroglossia, macrocheilia, &c.), which is rather of the nature of lymphangeioma.

Allied to the above conditions are *chylous hydrocœle* and *chylous ascites*, which result from blocking of the thoracic duct in the abdomen, the result being that the milky chyle escapes from the lacteals into the peritoneum or tunica vaginalis.

Treatment. The slighter and more transient cases are relieved till the obstruction abates by raising the limb, bandaging, and massage. In more severe cases where there is permanent destruction of large areas of lymphatic

channels, whether from operation or disease, a fresh path may be provided for the lymph by introducing thick silk strands (Handley) subcutaneously from the œdematous part to some loose subcutaneous tissue well above the site of obstruction. Thus for blocking of the axillary lymphatic vessels the upper end of the silk is in the supraclavicular fossa of the neck, the lower end in the forearm. The threads are introduced by making a small incision and pushing an eighteen-inch probe along under the skin for the required distance, cutting down on the end, threading with the silk, and withdrawing the probe : the apertures are closed : asepsis must be rigid. The operation is described as Lymphangeioplasty.

Fair results are obtained when the process is not progressive, as for fibrosis after operations, e.g. clearing the axilla in a complete removal of the breast. But where the obstruction is progressive, as from recurrence of malignant disease in the axilla, the operation is not satisfactory, and amputation is advisable if operation be attempted at all. For filarial elephantiasis Handley's method has only met with temporary success, in the legs. Where the scrotum is involved this must be removed by dissection, leaving the testes. Lymphatic fistulæ may persist for some while after such operations.

New Growths of the Lymphatic Vessels. These consist of capillary and cavernous nævi, hypertrophic nævi, and hygromata, which are innocent, while of malignant and quasi-malignant forms we find sarcomas and endotheliomas.

(I) Lymphatic nævi are similar in structure to blood-nævi. The superficial capillary type presents the appearance of dilated lymph spaces of translucent or yellowish colour on the skin and mucous membranes, which often rupture and discharge lymph. The cavernous varieties occur in the subcutaneous and submucous tissues, and closely resemble cavernous nævi except that, as they contain lymph and not blood, they do not appear bluish in colour. These last formations are the cause of many instances of the enlarged tongue and lips occurring congenitally (macrocheilia and macroglossia).

(2) The hypertrophic lymph-nævi consist of capillaries which are but little dilated, but the endothelial lining, instead of being flat, is cubical and proliferated. The little pink or yellow moles on the skin are of this nature. Pigmented moles are of very similar nature, but pigment cells are also present, the microscopical appearance being little different from that of melanotic cancer, of which indeed a pigmented mole may be the starting-point. Hairy moles are of the same nature as the last-mentioned group but with growth of coarse hairs, the skin being wrinkled and redundant ; sometimes these last are of great size, covering half the face.

The above tumours are removed by excision if inconvenient or disfiguring : skin-grafting will be needed after removal of the larger forms.

Cystic Hygroma. This tumour is formed of dilated lymphatic spaces which are cut off from the general lymph circulation. The result is a collection of spaces, often of considerable size, containing fluid varying in colour from pale straw to dark green or brown (presumably from the presence of

altered blood-pigment). Sometimes dilated lymphatic spaces connected with the ordinary lymphatics are found in such tumours.

Hygromas are found in situations where lymph-nodes are abundant, especially the neck, axilla, and subscapular regions, and are sometimes known as cystic lymphangeioma, hydrocœle of the neck, and lymphatic cysts. (Fig. 27.)

Signs. These formations are usually found in small children and infants, presenting the characters of painless cystic (often lobulated) swellings in the above-mentioned situations; they are to be distinguished from cold abscess cavernous nævi, and other congenital cysts such as dermoids.

FIG. 27. Cystic hygroma of the neck.

Treatment. Removal by dissection. As these cysts often spread into intermuscular planes and even into muscles, so that there may be some doubt as to their complete removal, it may be well, if in doubt, to pack the cavity with gauze for a few days. After removal of the latter the mild inflammation resulting from this procedure will cause more cicatrisation and obliteration of any small parts that have escaped removal.

Endotheliomas and sarcomas are described under Tumours. (Vol. i.)

INFLAMMATIONS AND INFECTIONS OF LYMPH-NODES (lymphadenitis). These affections may be divided into the acute, usually caused by pyogenic organisms, and the chronic indolent varieties, caused by the spirochæte, the tubercle bacillus, and less often by pyogenic organisms in small doses or of attenuated virulence.

Acute Lymphadenitis. This is nearly always due to infection carried along the afferent lymphatic channels to the gland, though inflammation of these and even the initial focus of infection may be inconspicuous.

Occurrence of lymphadenitis points to a victory of the invading organisms over the local defence of the surface of the body, and calls for more efficient treatment in that region. In very severe peripheral infections, *e.g.* spreading gangrene, the spread to lymph-glands may be but slight. The local cause varies from a slight scratch on a finger or a mild sore throat, causing pain and tenderness of the axillary or cervical glands respectively, to a severe

suppurative or cellulitic condition leading to violent suppurative changes in the affected lymph-nodes. The course of inflammation in lymph-glands is similar to the process elsewhere. Resolution may occur in the milder forms or suppuration may take place, the infection spreading to the surface of the glands, setting up peri-adenitis, which in turn may break down as a periglandular abscess and finally burst through the skin. Either condition on healing may lead to fibrosis and lymphatic obstruction. The severity of the local infection does not account altogether for the vehemence of the glandular inflammation. Thus a large glandular abscess may result from a tiny focus of infection on the surface, which may heal rapidly.

Signs. The patient feels pain in the region of the infected glands, which is increased on movement. The glands are enlarged, tender, and as a rule fever is marked. This condition may subside or the inflammation become more severe, the glands becoming large, matted together, and fluctuating as suppuration occurs ; still later the skin over the abscess becomes red and brawny as the abscess " points."

Treatment. The focus of infection must be efficiently treated if still active ; boils, abscesses, or cellulitis freely opened and drained. Locally the glands are treated expectantly in the early stages, pain being relieved by hot fomentations ; but as soon as the surgeon feels tolerably sure that pus is present, from the increase in size and tenderness of the swelling and brawniness of the skin, the glandular abscess should be opened. To wait till such an abscess points on the surface is a waste of time and increases the risk of further spread of infection, besides keeping the patient in unnecessary pain.

Operations on Abscesses of Lymph-Nodes. These occur in the neck, axilla and groin (as well as in the retro-pharyngeal region, mediastinum and abdomen, which are discussed in other sections).

Owing to the brawny infiltration around the glands, dissection is difficult and, fortunately, unnecessary. In all these regions there is real danger if the knife be freely and indiscriminately employed, as the large vessels are in immediate relation to the inflamed glands. For this reason such abscesses should be opened by blunt dissection (Hilton's method). The skin is incised and the knife carried just through the deep fascia but no further, the incision being over the most prominent and softest part of the swelling. After this some blunt-pointed forceps with the blades closed are thrust into the oedematous mass and pulled out again with the blades opened. If they are thrust boldly into the most prominent part of the swelling the abscess will be found as a rule. Beginners usually make the mistake of going too much to one side (being afraid of the vessels, but there is no danger of injuring these with blunt instruments). As regards forceps, the ordinary sinus-forceps are fairly good but a pair of artery-forceps (Spencer Wells) are better, because blunter at the end. It is also well to remember that in the *axilla* the main vessels hug the outer wall, so that the inner wall should be attacked to open an abscess. In the *groin* the incision should be made vertically, as this will cause it to gape more

readily and assist in promoting drainage. In the *neck* the incision should be parallel with the sternomastoid and the external jugular vein avoided.

Chronic Lymphadenitis. This may be pyogenic, tuberculous, and syphilitic.

Chronic pyogenic lymphadenitis is the result of repeated small doses or a slightly virulent infection, and is particularly common in the glands of the neck, the primary infection arising in sores of the scalp from pediculi, carious teeth, adenoids, chronic affections of the tonsils. The importance of this form of the disease is that tuberculosis is prone to develop in such damaged glands.

Clinically the condition can hardly be distinguished from that caused by tuberculosis in its earlier stages, except that where the primary focus is cured the glands usually subside, while they do not do so when infected with the tubercle bacillus. Mistakes in diagnosis, however, are easy to make, and tubercle bacilli have been found fairly often in enlarged tonsils and adenoid vegetations.

Fig. 28. Tuberculosis of glands. An enlarged and caseating gland is extracted just below the angle of the jaw. Below and behind this is a thickened puckered scar, characteristic of a healed tuberculous series.

Treatment. Any local sources of infection, such as adenoids, enlarged tonsils, carious teeth, pediculosis, &c., should be cured or removed, and if the glands do not subside in a few weeks after this is accomplished it is probable that the infection is tuberculous, and treatment as for tuberculous glands, including operative measures, should be carried out.

Ligneous Lymphadenitis. This ultra-chronic form with much fibrosis and peri-adenitis is allied to the similar condition ligneous cellulitis, and is also due to staphylococcal infection. The glands become enlarged, very hard, and adherent to the surrounding tissues ; suppuration is slight. These cases are difficult to cure ; opening and draining are insufficient ;

the mass should be dissected away, taking care of the large vessels, and if suppuration persists vaccines may be tried.

Tuberculous Lymphadenitis. This is a very common affection, especially in young subjects, though occurring at all ages. Of the external glands the cervical group and its tributaries are most often affected; next in frequency are the axillary glands, while the glands of the groin are not often involved. The glands of the internal organs less often come into surgical practice, being usually only diagnosed when the infection is too widespread for operative measures to be applicable. We have, however, on several occasions removed a localized mass of abdominal tuberculous glands, together with the ulcer of the intestine which was the initial focus of the disease, with very gratifying results. In the neck the sources of infection are the teeth, tonsils and adenoids, in which tubercle bacilli have been found not infrequently.

Anatomy. The glands become enlarged and macroscopically appear fleshy at this stage; there is increase of fibrous tissue and formation of typical giant cells and epithelioid systems, *i.e.* grey tubercles scattered throughout the gland; healing and fibrosis with shrinkage may occur. If the disease persists, yellow caseating areas appear in various places and, coalescing, form large cheesy masses comprising a large part of each gland, which may become softened and liquefied, resulting in cold abscesses. If healing occurs at this stage there is always a good deal of calcification associated with the reparative fibrosis. In a good many cases the liquefaction is much delayed and the yellow material remains tough and solid for some time, resembling the slough of a syphilitic gumma. Where liquefaction is much advanced there is nearly always a good deal of peri-adenitis, and the glands become bound together into masses and adherent to the surrounding tissues. Finally, if such cold abscesses do not become absorbed and calcified or fibrosed, they increase in size, escaping from the gland and forming a subcutaneous cold abscess which bursts on the surface of the skin, leading to the production of a sinus of the chronic type with thin, undermined, bluish, ill-nourished skin around—weak, anæmic, hypertrophic granulations discharging thin pus mixed with curds and debris. Healing may still occur after such an abscess has burst, leaving an ugly, puckered, thickened, often keloidal, scar with irregular tags of skin round about (Fig. 28).

Signs. In the early stages there will be found a rounded elastic or fluctuating mass or masses of varying size (from a pea to a hen's egg or larger) occurring in places where lymph-nodes are common (neck, axilla, or groin). Later the signs will be those of a cold abscess or tuberculous sinus in one of these situations.

Diagnosis. (a) From other glandular swellings. From chronic pyogenic infection, the fact that the latter condition usually clears up after cure of the primary focus and has little tendency to form cold abscesses is suggestive. The ligneous type of pyogenic lymphadenitis is much harder and more adherent to surrounding tissue than are tuberculous glands. From primary syphilis distinction is made by the presence of the primary·

sore in the drainage area and by the indolence of the glands, which remain discrete, neither tending to improve (apart from specific treatment) for months nor breaking down. From gummatous affection the diagnosis is less easy, but the spirochætal infection is more usual in the middle-aged, and the history and presence of scars in the palate, face and shins, as well as the serum reaction, will be suggestive. Of course, tuberculosis of glands may occur in syphilitics, and the best manner of testing is to give a full course of syphilitic treatment in doubtful cases, when the reaction to the latter will settle the diagnosis. From lymphadenoma diagnosis is assisted by the fact that in the latter condition the glands become much larger without either breaking down or becoming adherent, while the spleen is enlarged. Some tuberculous glands, however, grow very large without breaking down, and it is unwise to diagnose a case as lymphadenoma without removing a gland for microscopic investigation. Lympho-sarcoma grows far more rapidly and is early adherent to surrounding structures, both superficial and deep.

Secondary deposits of malignant tumours in glands are fixed early to their surroundings, and are locally much harder (even if soft and broken down in places), while the primary growth can often be found on more or less careful examination. In doubtful cases a portion of the mass should be removed for microscopical diagnosis.

(b) From other cystic swellings diagnosis will be needed after the glands have broken down. From hygromas the congenital origin of the latter and fluctuation of all parts of the swelling, there being no hard or fleshy glands round the fluctuating part, while from branchial cysts the fact that only one cystic mass is present with no outlying glands, will help, though the latter condition is usually mistaken for a large cold abscess.

Treatment. In the early stages where the glands are discrete, small and not softened, any possible local sources of infection are removed, including teeth, adenoids, &c., and the patient is placed under good conditions as to diet, air, sunshine, &c., and tonics, as cod-liver oil, iron, &c., administered. A good many cases will subside on these measures, but we must always be uncertain as to how many of these really are tuberculous and not mild pyogenic infections.

Where the glands are large and do not disappear on this treatment, or if they show signs of softening, they should be removed without delay and before periadenitis occurs, since the operation is much easier and likely to be more thorough and satisfactory if done fairly early. Removal of glands should be free, not taking merely those which are large and fluctuating but all the glands around these, both small and great, making a clean sweep of the affected part, or recurrence is likely. Where there is much periadenitis and cold abscesses of extensive nature excision may be impracticable, though exploration may be made to ascertain how far this is possible. Otherwise the abscesses are curetted, ill-nourished skin cut away, and bismuth paste injected, when healing will only occur with considerable scarring. Fairly often a large part of the operation may be excision of

masses of glands, with scraping of any intermuscular, cold abscess which cannot be removed by dissection. Finally, the surgeon should never think that operative measures alone will suffice to cure the condition, although early removal of caseating glands is a great part of the treatment. The general physical condition must be improved as described under Tuberculosis, or recurrence in other glands is extremely probable.

EXCISION OF TUBERCULOUS GLANDS. This should, if possible, be done before the glands are adherent ; hence if the condition is advancing, operation should be urged.

(1) *The Neck.* Where the glands are principally in the submaxillary group and the upper members of the deep cervical chain they may be reached by a curved, horizontal incision below the jaw in the line of the skin-folds of the neck. Where more room is needed (and there are always about three times as many glands to be removed as would appear from superficial examination), a second incision is carried down from the posterior extremity of the first along the posterior border of the sternomastoid to the clavicle, and if necessary horizontally back from the lower extremity of this, so that the whole incision has the form of a Z. Where the glands extend from the anterior into the posterior triangle beneath the sterno-mastoid this muscle should be divided below the point where it is pierced by the spinal-accessory nerve, as this will allow of better exposure and more satisfactory removal of affected glands. As mentioned, where many glands are affected a clean dissection of the area should be made as for malignant glands, leaving only muscles, vessels, and important nerves (Stiles). The external jugular and facial veins usually require division and tying ; the spinal-accessory, hypoglossal, vagus, and phrenic nerves are to be carefully avoided, especially the last two. Removal of the internal jugular vein is not advisable nor often needed, since if already removed on one side a second operation on the other side by the same procedure may lead to cerebral trouble. In most instances the glands can be stripped from the vein, and if the latter is punctured the hole will readily be stopped with lateral ligature. The cavity should be drained twenty-four hours.

(2) *The Axilla.* The infection may spread from the lower cervical glands, the breast or ribs, rarely from infection of the arm, fingers, or hand. The glands should be removed when resisting general treatment for two months or if very large or softening, and before becoming adherent. The incision is along the anterior wall of the axilla, the pectorals being drawn well forward ; as enough room can be obtained in this manner, there is no need to divide these muscles as in the more complicated excision of secondary cancerous glands.

In the groin the source of infection is generally obscure. Removal should be performed early, as when there is much periadenitis and sinuses removal becomes very difficult.

SYPHILITIC INFECTION OF LYMPH-NODES. This occurs in all three stages. In the primary stage the indolent bubo has been described, and

requires no further notice when found in the groin ; but where the chancre is extra genital, *e.g.* lip or nipple, the presence of large painless, discrete glands in the submaxillary region or axilla will assist in the diagnosis, since such chancres are often atypical. In the secondary stage of the disease general slight lymphadenitis is common, and most noted along the posterior border of the sternomastoid (external deep cervical chain), occipital, and epitrochlear glands. In the tertiary stage gummatous affection of lymph-glands resembles that due to the tubercle bacillus but occurs more often in middle age ; the glands are more matted together and adherent to surrounding structures, while their rapid disappearance on mercury and iodides renders diagnosis complete.

Fig. 29.   Lymphadenoma of cervical and axillary glands.

NEW GROWTHS AND ALLIED CONDITIONS OF LYMPH - NODES. *Lymphadenoma* (Hodgkin's disease). This little-understood disease, or group of diseases, consists of a hyperplasia of the lymphoid tissue, affecting chiefly the lymph-glands, but also the spleen and liver. The hyperplasia is of the supporting elements of the glands (branching cells), the lymphocytes contained being diminished greatly or absent. The underlying cause of this disease is unknown ; it is sometimes attributed to a tuberculous toxæmia, and in evidence of this it is noted very often that cases supposed to be lymphadenomatous later become tuberculous, the glands caseating. The possibility of errors in diagnosis are obvious here, for the more chronic varieties of tuberculous glands remain unsoftened and discrete for months and even years, and may attain a large size without undergoing further changes, so as to be indistinguishable from lymphadenoma unless portions are removed and submitted to microscopical investigation.

Signs. The disease commences with painless enlargement of the glands, usually in the cervical region in young subjects, often males. In some instances the hyperplasia remains localized, but more often the disease spreads to the glands of the axilla and groin, while the liver and spleen (hardbake spleen) become enlarged from similar changes in their lymphoid

constituents. Involvement of the mediastinal glands may lead to severe and fatal pressure on the œsophagus, bronchi, or bronchial veins; there is usually a secondary anæmia. The disease seems to be invariably fatal, usually in a few months, but life may be prolonged for several years. The disease is to be distinguished from widespread tuberculosis of glands by the large size that these attain without breaking down and the enlargement of the spleen, though, as has been mentioned, diagnosis cannot be considered certain unless sections have been examined.

Treatment. Surgical measures are not indicated except for diagnostic purposes. Administration of arsenic may improve the patient's condition for some time, while application of X-rays often causes the glands to disappear, but this does not in any way prolong the patient's life. Where a single group of glands only is involved it should be removed, though it is unlikely that such cases are really Hodgkin's disease.

LYMPHATIC LEUKÆMIA. This disease is characterized by anæmia with great excess of lymphocytes of various types in the blood, associated with enlargement of lymph-glands and lymphoid tissue generally. This disease is

FIG. 29A.   Lymphadenoma of cervical and axillary glands.

discussed in medical works, and it is sufficient here to mention that the diagnosis is made on an examination of the blood, when it becomes obvious.

Lympho-sarcoma is simply round-celled sarcoma originating in lymphoid tissue, which happens to be a favourite site of such tumours.

Signs. When originating in the thorax (mediastinal glands) the signs will be those of pressure on veins, œsophagus, bronchi, &c., rapidly increasing and soon fatal, with pleural effusion, &c. When commencing in external glands there is a rapid development of a rounded tumour in these glands, soon becoming adherent to and invading surrounding structures. The tumour often breaks down and soft areas appear in parts, while the skin may be ulcerated and a large fungating mass soon appear on the surface. The rapid growth, large size, and fixity distinguish from lymphadenoma and tuberculosis.

Treatment. Where occurring superficially, excision as soon as possible, followed by large doses of X-rays through an aluminium filter, will produce temporary cessation of growth and apparent cure, but whether real cure is possible may well be doubted.

SECONDARY TUMOURS IN LYMPH-GLANDS. These are far more common than primary tumours, and next in frequency to tuberculosis. Practically all invading epithelial (lepidic) tumours, with the exception of rodent ulcer, rapidly give rise to secondary deposits in glands, as do melanotic growths and sarcomas of lymph-glands, the testis, thyroid, and tonsil. It is important to recognize that these secondary deposits may assume a large size, while the primary growth is small and difficult to discover.

The hardness and early fixity of the resulting mass suggests cancerous origin, but where the primary growth is not found diagnosis may be uncertain till a portion is removed for microscopical examination.

The exact distribution of secondary malignant growths in lymphatic glands forms one of the advances of surgical knowledge of late years and is valuable, since it affords a means (if operation is done early) of removing the entire growth with all its possible secondary ramifications. Unfortunately, increased knowledge often shows that such spread is likely to be so wide as to be quite out of the range of surgical attack. The question of removing glands for secondary malignant infection, whether actual or potential, is discussed under the Surgery of the Stomach, Intestine, Breast, Tongue, &c.

SECTION V

ABDOMINAL SURGERY

In this section are considered the surgical affections of the abdo-
minal viscera, excepting the urinary system. The female organs
of generation are considered only so far as they obtrude themselves
into general abdominal surgery.

CHAPTER XIX

ABDOMINAL SURGERY, GENERAL CONSIDERATIONS, OPERATIVE TECHNIQUE, INJURIES, AFFECTIONS OF THE PERITONEUM, MESENTERY AND OMENTUM

The Peritoneum : Examination : Operative Technique : Incisions for Laparo-
tomy : Closing the Abdomen, Drainage : After-treatment : Suturing of Hollow
Viscera : Visceral Anastomosis : Injuries of the Abdomen and its Contents :
Penetrating and Gunshot Wounds : Subcutaneous Injuries : Treatment.
Peritonitis : Varieties : The " Acute Abdomen " : Diagnosis and Treatment :
Special Varieties of Acute Peritonitis : Localized Peritonitis : Pelvic Abscess :
Subphrenic Abscess : Tuberculous Peritonitis : Ascites, Treatment : The
Omentum : Injuries and Torsion : Mesenteric Glands, Mesenteric Cysts : Retro-
peritoneal Tumours.

Surgery of the abdominal contents presents certain peculiarities.

(a) The viscera, being partially loose in a large cavity, may be easily
handled and investigated with comparative safety if careful asepsis be
maintained.

(b) A large part of the intestinal tract is loosely attached by the mesen-
tery and can be drawn out of the abdominal cavity, which renders suturing
operations relatively easy.

(c) Partly owing to their being slung on the mesentery and partly
owing to the blood-supply being terminal or nearly so, the circulation can
be conveniently controlled for operative purposes, while on the other hand
it renders certain of the abdominal viscera very prone to gangrene from
kinks and twists, i.e. the blood-supply of the viscera is easily obstructed.

THE PERITONEUM. The peritoneum may be regarded as at once the
largest lymph-space and the largest joint in the body. In the first rôle
it affords a very large surface for the absorption of fluid of various sorts,
in the second it allows free play of the abdominal viscera on each other
whether from their own movements or produced by other parts of the body,
such as the diaphragm or abdominal muscles. The absorbent power of

the peritoneum is highly important, since not only are harmless substances such as saline solution, serum, blood, &c., absorbed, but poisonous substances, such as the toxines of bacteria or these organisms themselves, in this manner obtain entrance to the circulation and the body in general, which accounts for the rapid poisoning found in patients suffering from general peritonitis. Besides absorbing, this membrane has also the power of rapidly secreting fluid which may be fluid serum or coagulable lymph, and this effusion seems to have some power to inhibit the growth of infective organisms and to neutralize their toxines. The peritoneum is divided up into compartments or pouches by the mesentery, mesocolon, ligaments of the liver, &c., which have a bearing on the spread and generalisation of infection through the peritoneal cavity.

The absorbent power of the peritoneum, and hence its vulnerability, varies in different parts, being greater in its upper regions, especially about the diaphragm, than in the pelvic portion. This accounts for the importance of keeping the diaphragmatic well above the pelvic part (Fowler's position) in cases of infective peritonitis, so that the force of gravity helps to drain the exudate into the less dangerous pelvic region, for pelvic abscesses are far less deadly than those about the liver and stomach (subphrenic). A notable property of the peritoneum from the surgical standpoint is the rapidity with which it responds to irritation by pouring out an exudate of serum and coagulable lymph. The latter is most important since it appears in a few hours, with the following results :

(a) By its enveloping presence it walls off a focus of infection from the rest of the peritoneum and so prevents spread of infection.

(b) This plastic lymph soon organizes into bands and cords of fibrous tissue, which may in various ways cause gross interference with the passage of the contents of the intestine or with the blood-supply of the latter (see Intestinal Obstruction) ; and thus the exudate which was primarily beneficial, may prove later a grave menace to the patient. The visceral peritoneum is devoid of painful sensation. Hence a colostomy may be opened without the patient feeling anything and viscera may be sutured under very light anæsthesia. The parietal peritoneum, on the other hand, is very sensitive ; hence the anæsthesia must be deep for opening or suturing the abdominal wall or the patient will strain. Pulling on the viscera, however, causes pain and shock, as often seen in operations on the stomach, probably from stimulating the mesenteric nerves and vagus.

GENERAL EXAMINATION. In examining an abdominal case the attention must be directed to the patient's complaint as regards pain, whether fixed and constant, suggesting some inflammatory condition, or intermittent and paroxysmal, of the nature of " colic," such as found in obstruction of the intestine, in gall-stone attacks, &c. Inquiry is made concerning the abdominal functions, viz. eating and drinking, whether unpleasant or painful, the relation of pain to meals in time and its position in the abdomen, e.g. in the gall-bladder or appendix regions ; the action of the bowels will then be examined.

Disorders of function are then noted, such as vomiting, its relation to feeding and character. Where constipation is present its degree is noted, whether merely of fæces or of flatus as well (absolute constipation).

Of physical signs, the pinched face of acute abdominal disease is, with experience, easily recognized, also jaundice. The tongue and teeth are of importance, especially in upper abdominal lesions, while the dry, brown tongue of acute abdominal disease is characteristic. The condition of the abdomen is next investigated as to distension and movement on respiration. Tenderness and rigidity, pointing to local or general peritonitis, are of importance, as well as the finding of abnormal swellings and the condition of the viscera, as ascertained by palpation and percussion. The pelvic viscera are investigated by examining the rectum and vagina with the finger and with specula, while the bladder is to be excluded by emptying with a catheter in the case of abdominal tumours rising from the pelvis. or examined with the cystoscope, when information concerning the ureter may be of value.

In practice the most important thing to recognize is whether immediate operation is essential, *i.e.* whether the condition is one of what is often termed " the acute abdomen " ; considerable experience is needed for this, and the signs of the condition suggested above are described more fully under the surgery of the various portions of the abdomen.

OPERATIVE TECHNIQUE

This concerns preparation for operation, parietal incisions, methods of closure of the abdominal wall, after-treatment, suturing and anastomosis of the hollow viscera.

PREPARATION FOR OPERATION. Cases fall into two groups :

(1) Non-urgent cases, where a few days' delay makes little or no difference to the patient.

(2) Urgent cases, where it is necessary to open the abdomen at the earliest moment, usually known as cases of " acute abdomen."

(1) The preparation as regards diet will be as for other cases where an anæsthetic is administered, viz. the stomach emptied (to avoid the danger of aspirating vomitus while unconscious) by fasting for twelve hours preceding the operation. In old or debilitated subjects or where the operation is likely to be severe, a few ounces of beef-tea or egg-and-milk should be given three hours before, while a pint or two of saline solution per rectum should in such cases always be given an hour before the operation commences. The bowel should be emptied by castor-oil given about. thirty-six hours before operation, followed by enemas twenty-four and twelve hours before operation. In this way the intestine is cleared of a large amount of putrefactive organisms and the amount of flatus in the intestine is diminished, rendering the difficulties from distension of the gut far less. Distension of intestine is one of the serious troubles met with in abdominal operations and should be avoided whenever possible.

(2) In urgent cases a purgative should never be given, as it will increase

shock and possibly make the condition far worse, *e.g.* where the affection is intestinal obstruction. The stomach should be emptied with a stomach-tube if vomiting is copious and insistent (in the majority of these cases the stomach has already been well emptied by previous vomiting). Enemata should only be administered in doubtful cases of intestinal obstruction, and then rather as a means of diagnosis than as a preparation for operating ; for in urgent cases of peritonitis and obstruction an enema only wastes time, adds to the shock, and may convert a local abscess into general peritonitis. In short, the occasional use of the stomach-tube will be the only preparation directed to the digestive tract in urgent abdominal conditions.

The skin is prepared in the usual manner, being shaved dry and painted with iodine 2 per cent. in spirit an hour before operation, covered with aseptic dressing, and painted again immediately before the incision is made. In urgent cases the two coats of iodine solution may be applied when the patient is on the operating-table, and seems just as efficacious. Care should be taken that the umbilicus is well cleansed, in addition to any folds of skin in fat persons.

The bladder should be emptied, with catheter if necessary, before the abdomen is opened, as it may, if distended, be injured when the incision is carried low, as for exploring the pelvis.

Shock. This is an important factor in abdominal operations of any magnitude, and is prevented by the use of saline per rectum as advised. In addition the patient should be kept warm, the temperature of the room being 75° to 80°, and the limbs bandaged with Gamgee tissue ; the table is kept warm by hot-water tins or electric heating. Nerve-blocking by administration of intraspinal anæsthesia may be advisable in the more severe operations in feeble patients, *e.g.* intestinal obstruction, removal of the prostate, or excision of the rectum.

Position. The patient lies flat on the back (dorsal position) as a rule, but for pelvic operations the pelvis should be tilted above the head, as this causes the intestines to fall away from the pelvis and render manipulations in that region more easy. There is no need, however, to stand the patient on her head, as practised by some operators, as this embarrasses respiration ; inclination of 30° with the horizontal suffices for most operations. Further, this position should be used with caution where pelvic suppuration is suspected or the upper abdomen may be flooded with pus, and the danger to the more delicate peritoneum of the upper abdomen has been mentioned. Again, in intestinal obstruction the position may lead to regurgitation of fluid from the stomach and danger of its being aspirated. The arms are best tucked under the buttocks and are never placed over the head, or injury to the brachial plexus is likely if the position be long maintained. The abdominal cavity being large, with numerous places of concealment ramifying in all directions, it is easy to leave instruments, swabs, &c., inside unless these be counted before and after operation. Sponges, gauze squares, &c., should be in definite numbers, threes or twelves, and counted. Loose swabs should never be placed in the abdomen unless

brought out again at once, and if gauze, &c., is placed there a portion should be allowed to remain outside, or a piece of silk should be secured to it at the end of which an artery-clip is fastened as a reminder of the presence of the foreign body inside the abdomen. In a great many cases all swabbing can be done with gauze, and as this material can be sterilized by heat it is theoretically preferable to marine sponges. Where there is gross hæmorrhage or large effusion to be removed there is nothing to compare with marine sponges, and these will always maintain their place where rapidity of swabbing is a consideration ; they can be rendered sufficiently sterile
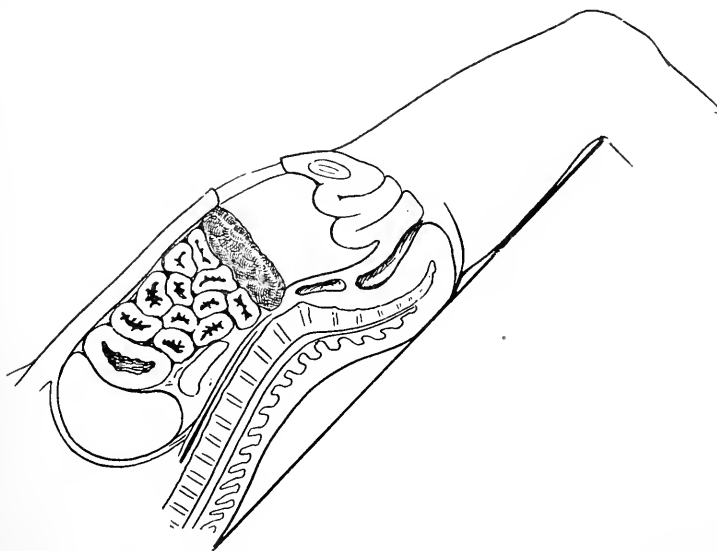

Fig. 30.   Trendelenberg position : the intestines packed off with gauze, the pelvis clear for operation.

by soaking in 1 in 20 carbolic for fourteen days. They should be kept in jars in threes or sixes and counted religiously before and after use.

Lotions. For the surgeon's hands biniodide of mercury 1 in 5000 is safe and not irritating. For washing out cavities—which, be it noted, is seldom advisable—saline solution should be used. The dilute biniodide solution may be employed for sponging parts that have been fouled with intestinal contents, &c., but this should be washed off again with saline. In most cases where the peritoneum is soiled gentle swabbing will suffice to cleanse it, the peritoneum being competent to deal with the microscopic residuum.

OPENING THE ABDOMEN, PARIETAL INCISIONS. In opening the abdomen it will be noted :

(*a*) That the incision should afford easy access to the site of proposed operation in order that the latter may be conducted as safely and speedily as possible.

(*b*) As little damage as possible must be done to the abdominal wall in order that risk of subsequent hernia through the wall (incisional hernia) be avoided. It is easy to open the abdomen, but to leave it decently closed

requires some circumspection. If possible, muscles should not be divided and nerves always spared. In many instances diagnosis cannot be made with sufficient accuracy to suggest an incision over a definite organ, and
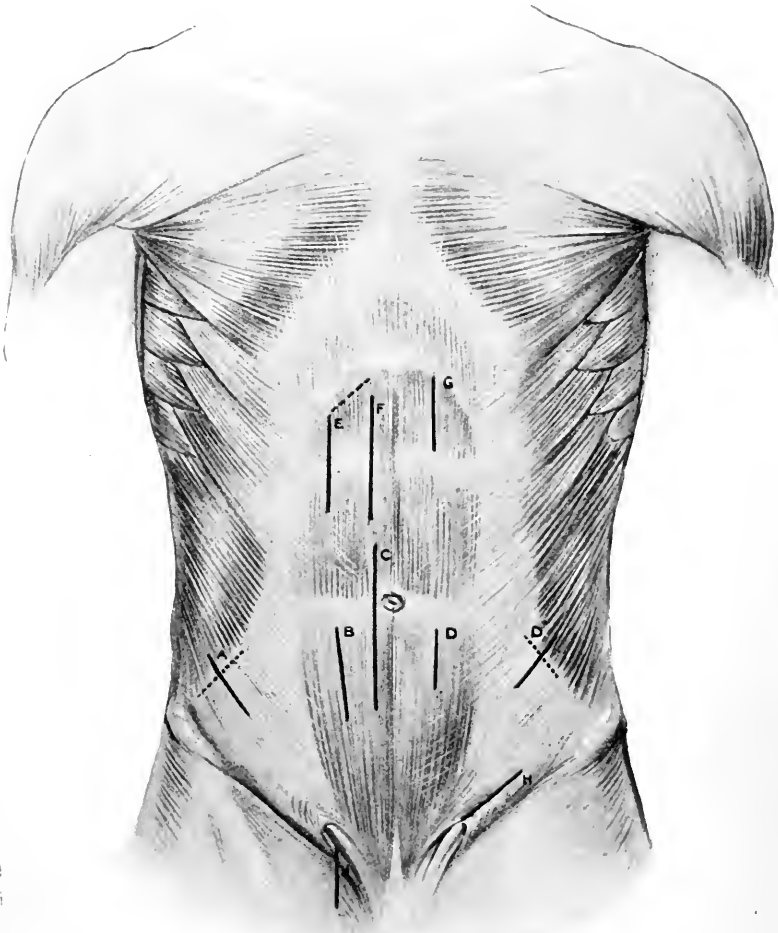
Fig. 31. Abdominal incisions. A, Muscle-splitting for appendicectomy : dotted line shows direction of internal oblique and transversalis. B, Right rectus incision (low). C, Paramedial incision. D, For colostomy through rectus. D′, For inguinal colostomy (muscle-splitting). E, For gall-bladder, can be enlarged along the dotted line. F, Paramedial incision for stomach, duodenum, pancreas, &c. G, For gastrostomy. H, For inguinal hernia. I, For femoral hernia.

as most organs can be reached from the middle line an incision in this region will very often be advisable.

Paramedial Laparotomy. The linea alba is comparatively bloodless and does not form a firm scar, being likely to give way, and therefore incisions should not be made directly in the middle line but at least an inch on either side through the anterior rectus sheath ; the rectus muscle is then displaced

outwards and its posterior sheath divided about an inch from the middle line. In this way the opening in the abdominal wall is valvular and the risk of a subsequent hernia is reduced. This can be done easily below the umbilicus, but above the adherence of the tendinous intersections of the rectus to the sheath renders the proceeding more difficult, and then we carry the incision straight through the rectus an inch from the mid-line, splitting the muscle longitudinally. The thickness of the abdominal wall renders a hernia unlikely. The rectus may be pulled inwards after dividing the anterior layer of its sheath : this plan is mostly used in the lower right rectus (Battle) for exposing the appendix and cæcum, but such an incision, if of any length, must divide nerves and paralyse the lower abdominal muscles ; hence where a long incision is likely to be needed it is better to
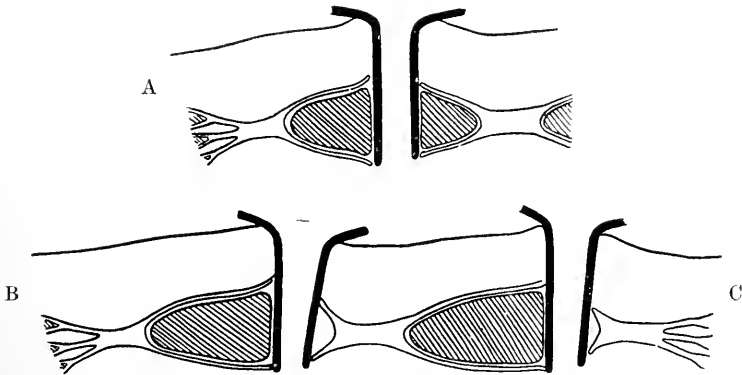

Fig. 32. Paramedial laparotomy incisions (diagrammatic sections). A. Splitting the rectus. B, Displacing the rectus outwards, and C, Displacing the rectus inwards.

retract the rectus outwards, thus sparing its nerves. Another serviceable method is the " muscle-splitting " or " gridiron " incision of McBurney. Here the incision is carried through the external oblique, splitting its fibres along their course. The opening thus made being well opened with re-tractors, the internal oblique and transversalis are split along their fibres, the second incision being nearly at right angles to the former. When the abdominal wall is split in this manner, the pull of the muscles as they contract serves to close the aperture in the parietes very efficiently and the chance of hernia is extremely small. This incision is very often used for operations on the appendix ; its drawback is that the space is rather limited, but if it be continued through the rectus sheath and the latter muscle retracted the amount of available room is considerable.

When the fascia and muscles have been split or divided the peritoneum is picked up and cut through, opening the abdominal cavity. This is usually simple, but where the peritoneum is thickened by inflammation it should be done with caution as the intestine may be adherent and readily opened, as it is difficult to judge where the peritoneum ends and the viscus begins. The normal peritoneum is not much thicker than tissue-paper,

and is thus recognized from the thicker-walled gut. Where the peritoneum is thickened and relations are obscured it will be often better to choose a part away from the site of inflammation and open it there instead of grubbing about in thickened peritoneum and perhaps opening the intestine. Should the gut be inadvertently opened, it must be closed at once with a continuous suture of fine chromic catgut, reinforced by another of fine silk, and then there is little prospect of serious mischief arising. When the peritoneum is satisfactorily opened two fingers are inserted, and, guarding the viscera with these, the wound is enlarged with a bistoury to the full extent of the incision through the abdominal wall. Through the incision thus made the fingers or hand (according to the nature of the case) are introduced and exploration made, the incision being enlarged if necessary. It is well to form some idea of the size of incision which is likely to be needed as soon as possible, or much valuable time may be lost in attempting to perform an operation through too small an incision, while constant nicking of the extremities of the opening is not conducive to skilful workmanship.

Packing off Intestines. Where the operation is of any magnitude it will be necessary to prevent the intestines obtruding themselves into the field of operation, both because unruly intestines are a great nuisance to the surgeon and because exposure of these delicate viscera greatly increases the shock of the patient ; moreover, the endothelial covering is readily injured, causing plastic inflammation and later adhesions to form. Intestines are packed off from the field of operation with sterile sponges or gauze, which in more extensive cases should be wrung out of warm saline. Where during operation any intestine escapes and cannot be at once replaced, it must be kept covered with sponges, gauze, or towels wrung out of warm saline and kept constantly warm. This packing off is very essential where some infective focus, such as an abscess, has to be opened through the abdominal cavity in order that the escaping pus may not be disseminated amongst the intestines and set up general peritonitis.

Peritoneal Toilette. Before closing the wound all bleeding-points must be tied, since no bandaging can affect the interior of the abdominal cavity ; all clot must be removed, swabbing gently and lightly in order not to damage the delicate endothelium of the peritoneum. It is essential to remove clots, since they offer an excellent medium for the growth of pathogenic organisms and, being slowly absorbed, may cause trouble from adhesions later. For the same reason (to prevent adhesions) all raw surfaces are covered in with peritoneum or omentum is drawn over them, since adhesions after operations are a fertile source of intestinal obstruction. No apertures are to be left in the mesentery, omentum, or between anastomosed viscera, or coils of gut are likely to become snared in these and intestinal obstruction results.

CLOSURE OF THE ABDOMINAL WOUND. This should be done, for choice, in layers, the peritoneum and often the posterior sheath of the rectus being taken together and united with a continuous suture. There should always be at least one layer of interrupted sutures : in the case of incisions traversing

the rectus sheath the anterior layer should be united in this manner, as it
is far stronger and more important than the posterior lamina. For the
gridiron incision the interrupted sutures will unite the internal oblique
and transversalis. Chromicized catgut does well for these sutures, though
some employ silk, linen, thread, &c. The skin may be closed with silkworm-
gut or Michel's clips, according to habit. Where there is much tension on
the abdominal wall, as in stout persons after operations for intestinal
obstruction, it may be impracticable to close the wound in the above manner,
since the sutures in the peritoneum and posterior sheath of the rectus cut
out too readily. A convenient plan, then, is to use stout silkworm-gut,
passing through all the layers (peritoneum, muscle, fascia, and skin), all
the sutures being passed before any
are tied. Then the ends on each
side are collected together and drawn
taut to prevent loops of intestine
escaping while the fascia (anterior
sheath) is united, which is done with
interrupted sutures of chromic catgut.
When this has been done the through-
and-through sutures are tied one at
a time, taking care that the remainder
do not become slack, or intestine may
protrude between them and become
strangulated. This is an excellent
plan in difficult cases.

DRAINAGE. This is only advisable
under certain conditions, for the
peritoneum can deal effectively with
minor degrees of effusion, and ad-
hesions form so rapidly that a drain-

Fig. 33. Closing a laparotomy incision.
A, By means of a suture through all the
layers reinforced by sutures in the anterior
sheath of the rectus and supplemented by
skin sutures. B, Closing in layers, viz.:
(1) peritoneum and posterior sheath; (2) re-
placing the rectus; (3) closing the anterior
sheath; (4) closing the skin.

tube often only acts as such for a few hours when placed into the general
peritoneal cavity, the tube resting in cavity surrounded with plastic lymph.
Drainage is serviceable where there is either a definite abscess cavity
or for a short time where there is large effusion into the peritoneum, as
after perforation of a gastric or duodenal ulcer.

(a) In treating a localized abscess the latter is walled off by a gauze-
or sponge-pack and opened, the interior swabbed clear of all obvious pus,
and the cause of this dealt with (e.g. removal of the appendix); a tube is
inserted into the cavity and the packing material removed. There is
practically no risk of infection spreading from the abscess into the peri-
toneum at the point where the tube enters the cavity, since adhesions form
round in a few hours. In three or four days the tube is removed or shortened
so as to extend just through the abdominal wall, the fistulous tract soon
closing. Occasionally abscesses treated in this manner recur, and the
possibility must be borne in mind if the case is not progressing favourably;
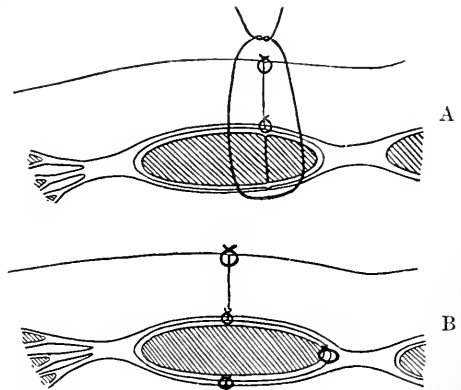on the other hand, the too long maintenance of a tube in situ is often the

cause of a long-lasting sinus, and sometimes of ulceration of the intestine and fæcal fistula.

(b) Where there is a large effusion, as in cases of perforated gastric ulcer, it is often impossible to sponge away all the effusion. In such conditions the patient is placed in the semi-recumbent (Fowler) position with a large drain-tube in Douglas's pouch in the pelvis, inserted above the pubis or per vaginam. The products of inflammation gravitate to the pelvis and escape by the tube till adhesions form. The tube is removed when it no longer promotes drainage, *i.e.* usually in two to four days (Fig. 34).

Gauze is useless as a means of drainage in abdominal cases, but on the contrary acts as a most efficient bung for retaining pus; it is, however, useful to pack a ragged cavity where bleeding is profuse and ligatures cut through the softened and inflamed tissues. When used for this purpose it may be removed in twelve to twenty-four hours, the sooner the better, since it is irritating and likely to keep up persistent vomiting.

After-treatment. The patient is placed horizontally in bed on one side to allow of ready exit of vomitus from the mouth. Where there is great shock the foot of the bed is raised eighteen inches, plenty of warm bottles placed around the patient, and saline infusion administered by rectum or subcutaneously. In cases, however, where there is infective effusion into the peritoneum, the foot of the bed should not be raised even though shock be severe, owing to the danger of infection spreading to the upper part of the abdomen. In such cases the limbs should be bandaged as an alternative. In all cases where there is peritonitis or this is likely to arise, *e.g.* cases of appendix abscess, the head of the bed should be raised or the patient slung in a semi-recumbent position (Fowler) as soon as he is round from the anæsthetic and the worst part of the shock has passed off : this position is of value in cases where vomiting is troublesome and after gastric operations.

Feeding and Drinking. For the first six hours the mouth should be sponged and rinsed out with hot water, after which, if vomiting has ceased, small amounts of hot water may be swallowed if thirst be severe (an ounce half-hourly may be allowed), but if vomiting be caused it should be stopped and fluid given per rectum only for another twelve hours or more. After twenty-four hours milk and barley-water may be given two-hourly in one-ounce feeds, increasing till four ounces are given. On the third day milk-and-egg or custard may be given, and after this light solids are commenced, such as fish and thin bread-and-butter. Where vomiting is persistent the stomach should be washed out and nothing given by mouth except one-minim doses of tincture of capsicum or iodine in one dram of water, and grain doses of calomel are given every two hours for four doses, followed by a turpentine enema. Morphia should not be withheld in abdominal cases if the patient is restless, especially on the first night after operation. In cases where peritonitis is present or likely to arise the bowels should be moved early with calomel and enemata, while strychnine gr. $\frac{1}{30}$ is given four-hourly to promote peristalsis and the passage of flatus : both forms of treatment are commenced as soon as possible after the operation.

In ordinary cases it will suffice to move the bowels on the third day with castor-oil and an enema, but earlier where there is much flatulence and discomfort.

SUTURING OF HOLLOW VISCERA. This forms a very important part of the technique of abdominal surgery, for it is often necessary to remove portions of intestine or stomach or to close apertures, whether accidental or of surgical origin, in such viscera, or to perform anastomosis between hollow viscera. In no branch of surgery has more ingenuity been shown than in the suture and junction of hollow organs; many varieties of stitches, bobbins, clamps, and buttons have been devised to facilitate operations of this sort, but simple suture holds its own against all rivals, and it is essential to acquire a simple and speedy method of performing this class of operation.

Intestinal Clamps and their Substitutes. Before commencing any operation of this type steps are taken to prevent extravasation of the contents of the viscera in question, which may be of considerable toxicity in the case of the lower intestine or fairly innocuous in the case of
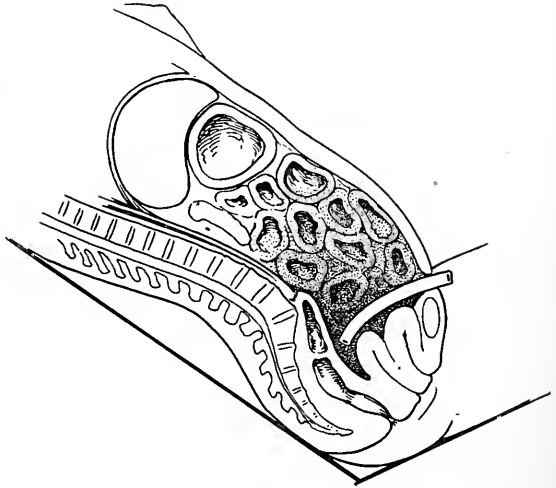

FIG. 34. Fowler's position, showing how the peritoneal exudate gravitates to the pelvis, and how it may be drained off.

the normal gall-bladder. Where no special instruments are to hand the viscus may be held by the fingers and thumbs of the assistant (a tedious and uncertain plan). Better is it in the case of the intestine to pass a rubber drain-tube or a strip of gauze through the mesentery and tie lightly round the gut above and below the site of proposed operation, having first emptied the contents by milking into the adjacent parts. Another plan is to pass a large safety-pin through the mesentery and insert a piece of sponge into its grasp, and then closing it so that the sponge compresses the intestine. The most generally useful instrument to prevent extravasation is a locking-clamp with elastic, flexible blades of the Kocher type; the blades are generally covered with rubber tubing to prevent injury to the clamped viscus. These clamps have the advantage of not only preventing extravasation of infective matter but also act as hæmostatic forceps and prevent escape of blood, thus rendering the field of operation less obscured, while in addition they help to maintain the portions of viscera in apposition when anastomosis is being performed. When suturing anything more than the smallest apertures the following conditions must be fulfilled :

(a) The surfaces must be in firm apposition, which can only be attained

by a layer of sutures piercing *all* coats of the viscera (mucous, muscular, and peritoneal).

(*b*) The internal lining or mucosa must be carefully excluded from the outside of the junction, *i.e.* the suture-line on its outer surface must bring peritoneum into apposition with peritoneum throughout its whole length in order to prevent peritonitis and adhesions from infection by the mucous lining. To secure this two layers of sutures are advisable : first the apposing, fixing, and hæmostatic layer, penetrating all coats of the viscera engaged ; secondly, the toilet or peritoneal layer, picking up the peritoneum and
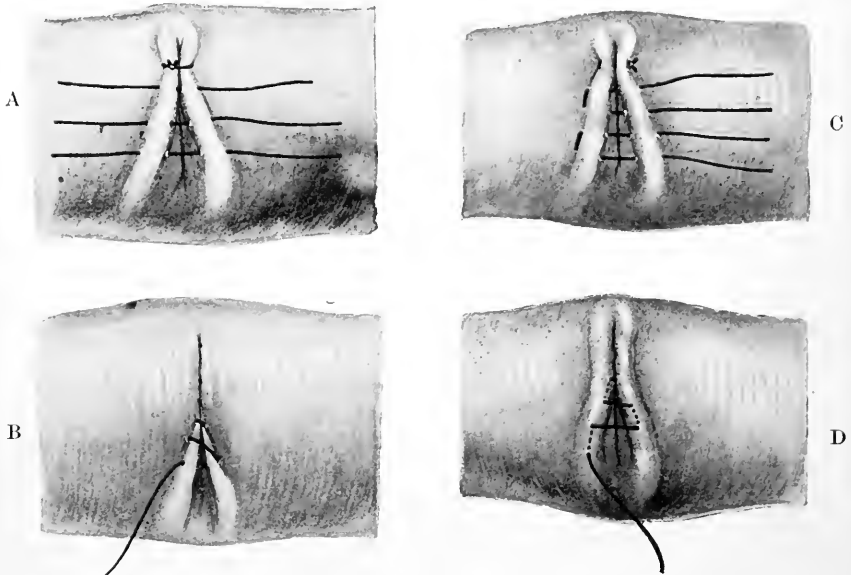

Fig. 35. Methods of suturing the peritoneum. A, Interrupted Lembert. B, Continuous Lembert. C, Interrupted mattress. D, Continuous mattress. (Cushing.)

subperitoneal layers and bringing them nicely over the first layer. It is possible to unite intestine satisfactorily by means of one row of sutures if very careful workmanship be applied, yet even in skilled hands this is not without risk, and as the insertion of the second peritoneal layer does not add greatly to the time of operation and renders the junction far safer, it is therefore advisable.

The suture should be continuous ; interrupted stitches take far too long (speed in the larger abdominal operations makes for success) and is no more secure. But the continuous suture must be pulled tight as each stitch is passed so that the viscus is puckered slightly, and the thread should be knotted at two opposite points in cases where the suture surrounds an aperture (as in performing an anastomosis), else the constant traction will cause the suture to act as a purse-string and close up the aperture. It is easiest to work from the (surgeon's) left to right, holding the thread taut with the left hand and thus keeping each stitch tight, and at the same time pulling the viscus up slightly so that it comes readily to the needle.

The advantage of straight needles is obvious ; curved needles and holders are only needed when operating at the bottom of a hole, and this position is to be studiously avoided and only adopted as a last resource, as in suturing a perforated duodenal ulcer.

The needles employed are round in the body and sharp only at the point, *i.e.* of the type used for ordinary sewing, but more slender ; split-eyed needles are a great boon from the ease with which they may be re-threaded.

The suture material for the deep or fixation layer should be fine chromic catgut, because, as part of this enters into the septic cavity of the intestine it may, if not absorbed fairly soon by capillary action, allow of passage of the contents of the viscera to the suture-line and cause infection there. The outer peritoneal layer should be of fine silk, size 00 to 1 in thickness. As regards the methods of suturing, the ordinary overhand stitch serves most purposes for the deep layer, but in some places the method of Connell is useful, bringing the peritoneum more squarely into apposition and effectively inverting the edges, though in most places this is not needed if a peritoneal layer be applied outside. The latter layer may be applied as a continuous Lembert or by Cushing's method, or more often something between the two, and so long as the peritoneum is made to thoroughly overlap the deeper suture-line the exact method of suturing is of slight importance. (Figs. 35–38.)

ANASTOMOSIS OF VISCERA. It is often necessary to perform anastomosis between viscera to obviate an obstruction to drain some viscus, *e.g.* the stomach, or to restore the continuity of the alimentary canal after some part has been removed.

Whether suturing or mechanical devices are employed, there are three types of operation for forming anastomoses :

(1) End-to-end anastomosis or circular enterorrhaphy.

(2) Lateral anastomosis.

(3) End-to-side anastomosis.

The second is by far the more generally useful method, since to perform end-to-end anastomosis the two ends must be of about the same size, for if one has to be reduced by suturing the difficulty of making a well-fitting anastomosis is considerable, and it only occasionally happens that two portions of intestine are of similar size, the upper being usually distended by previous intestinal obstruction. Moreover, a lateral anastomosis can almost always be employed in cases where circular enterorraphy might be done, while the converse does not hold good. Where an end-to-end anastomosis is possible it takes rather less time than a lateral anastomosis.

(1) *End-to-end Anastomosis.* This is employed where a portion of intestine has been excised or where the gut has been torn across, if the two portions are of about the same size. It has the disadvantage of somewhat reducing the lumen at the point of suturing, but takes less time than lateral anastomosis with closure of the ends. Intestinal clamps are placed three inches from the ends of the portions to be anastomosed, and the remaining intestinal contents carefully squeezed out and sponged away.

The cut ends are brought together so that the mesenteric border corresponds, and this part should be sutured first, as being the most difficult place to ensure good union and where leakage is most likely to take place. The first suture is inserted squarely on the Connell or glover's plan, embracing the mesenteric attachments and inverting the edges so that the external
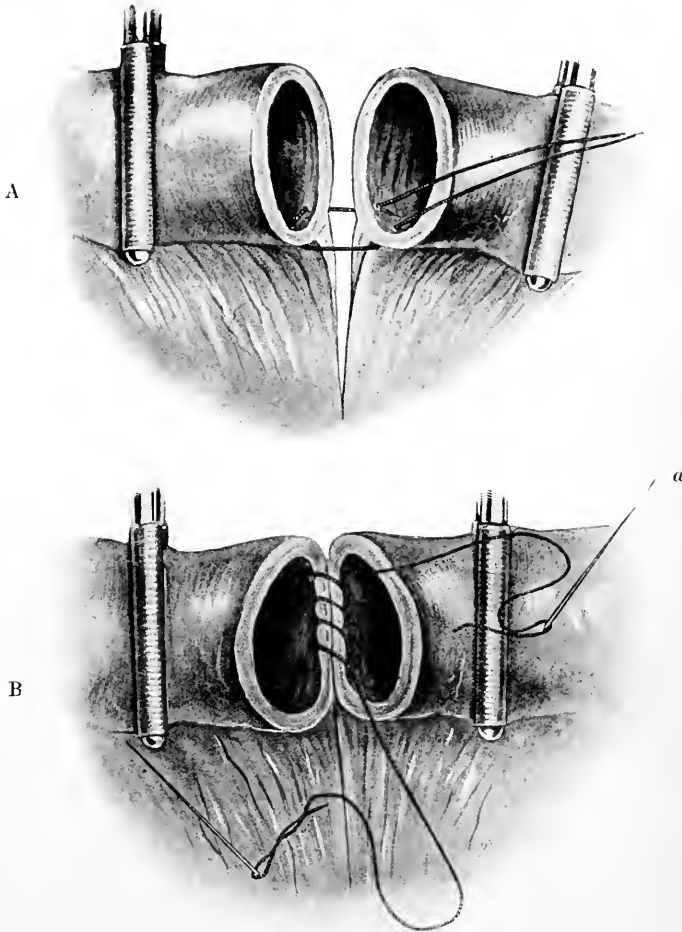

Fig. 36. End-to-end anastomosis of intestine. A, Insertion of mattress suture to secure adequate inversion at the mesenteric border. B, One end of the mattress suture (a) employed as a through-and-through overhand stitch to unite the intestine. The other end (b) will be similarly employed and the two united at the anti-mesenteric border. The whole suture line is then covered in with a peritoneal suture line.

surfaces are in good apposition : this suture is tied, both ends left long, and each used in turn to take the suture half-way round the circumference of the intestine. After the first stitch it matters not whether the ordinary overhand or the Connell method be used ; the former is easier and quicker. Each end of the suture is tied and then knotted to its fellow at the anti-mesenteric border, and the inner apposing and hæmostatic layer is complete. The outer peritoneal layer of silk is now inserted, commencing at the mesen-

tery and including some of the latter on either side, and taking each suture half-way round to meet the other at the anti-mesenteric border : only peritoneum and the subjacent areolar tissue are picked up, and care is taken that the mucosa is thoroughly covered and invaginated, each stitch being drawn tight.   The sutures being thus tied at the mesenteric and also the opposite point of the circumference of the intestine, there is no chance of purse-stringing taking place and the lumen being diminished.   Finally, the rent in the mesentery is sutured with fine silk to avoid the possibility of a loop of gut prolapsing through and becoming strangulated, and the anastomosis is complete.   The line of union is sponged gently with warm saline and returned to the abdomen.   Guide-sutures are not necessary and may be omitted, as being of no assistance and taking up time.

(2) *Lateral Anastomosis*. This operation is the basis of a large part of abdominal surgery, being equally useful for performing short - circuiting operations around obstructions as for re-storing the continuity of the intestinal lumen after a re-section.   For the sake of sim-plicity we will imagine that the anastomosis is to be performed between two loops of intestine. Each loop is drawn through an intestinal clamp, so that the latter obstructs the lumen above and below the ·site of anasto-

Fig. 36A.   End-to-end anastomosis of intestine. Showing the insertion of the peritoneal layer of sutures which also has closed the gap in the mesentery.

mosis.   In the case of the intestine the whole circumference of the viscus can be drawn through the clamp, but, naturally, where the stomach forms one of the organs to be anastomosed only a part is clamped off, of sufficient size to enable the operator to carry out his proceedings with reasonable facility.   The clamps are brought parallel and close together so that the loops of intestine are in contact, and the first layer of sutures is passed.   This is a continuous Lembert of fine silk uniting the peritoneum of the two loops together for two and a half to three and a half inches ; after tying, the initial and terminal ends of the silk are left long and a clip placed on each for convenience in keeping them out of the way.   The loops are incised longitudinally parallel to the suture-line and one-eighth of an inch from it, the incision being one-eighth of an inch shorter than the suture-line.   The incision opens the lumen of the viscus, and is most readily made with small blunt-ended scissors, snipping into the lumen at one end of the suture-line and carrying them along to the required distance with one blade inside the lumen.   Next, and swiftly, the contents of the gut are swabbed away till the two sequestered
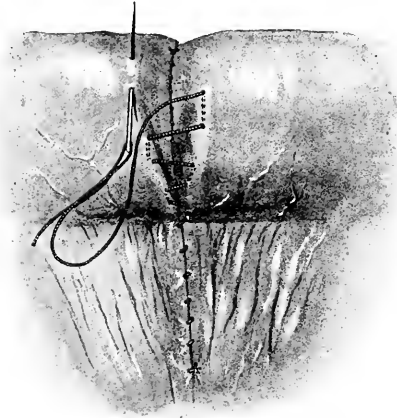
pieces of intestine are void of fæcal content. In both the stomach and
upper part of the small intestine, after the lumen is opened, the mucosa will
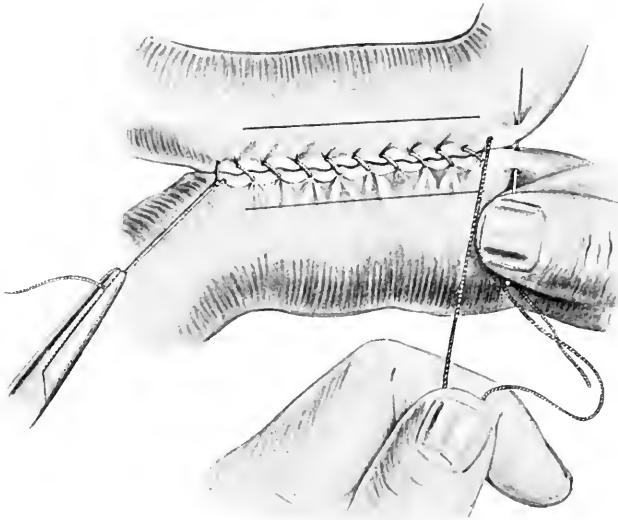

FIG. 37. Lateral anastomosis of intestine. The posterior peritoneal layer of
suture nearly complete. The lines parallel to this indicate the openings made
into the intestine to form the "stoma." Note that the suture is kept taut all
the time while executing the next stitch. (First layer of sutures.)

protrude in such a redundant manner that a strip must be cut away all
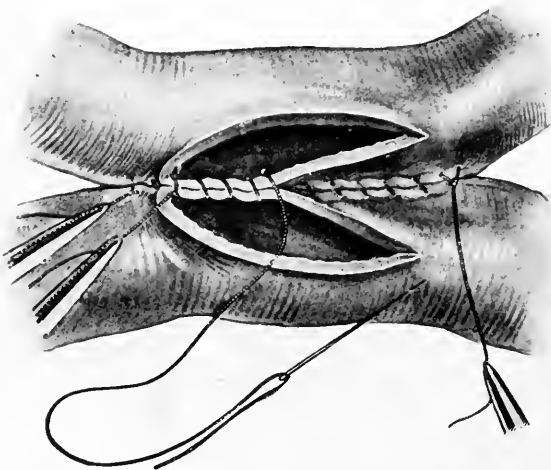round, nearly, but not quite, up to the edge of the opening into the intestine,

FIG. 37A. Lateral anastomosis of intestine. Commencement of the posterior part
of the through-and-through fixing and hæmostatic layer. (Second layer of sutures.)

or suturing will be difficult; in the case of the large intestine and ileum
this step is not needed as the mucosa is less redundant. The next layer is

of fine chromic gut, and is part of the deep apposing and hæmostatic layer. Starting again at the left end, the suture includes all coats of both viscera, and is passed in an overhand manner and tied at each end as before, the
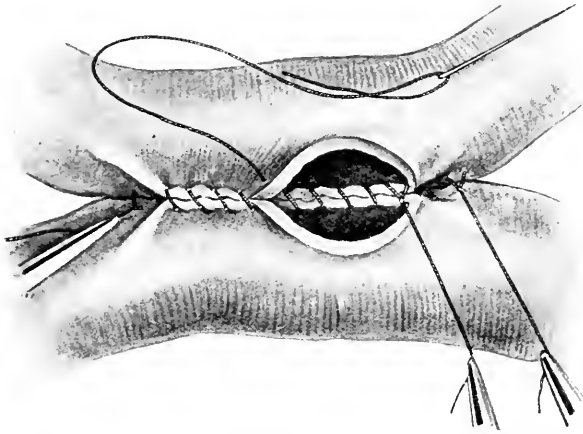
Fig. 37B. Lateral anastomosis of intestine. The anterior part of the through-and-through suture is half done (this when complete surrounds the stoma, and is tied to the long end of thread held in the clip on the left; third layer of sutures).

ends being left long. The third layer is of the same nature (apposing and hæmostatic) and also commences at the left end; after knotting the com-
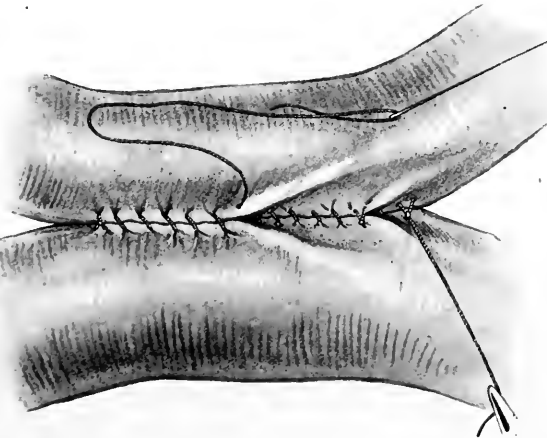
Fig. 37C. Lateral anastomosis of intestine. The anterior part of the peritoneal (toilet) layer of sutures is almost complete; under this is seen part of the through-and-through suture. (Fourth layer of sutures.)

mencement, the free end is tied to the long end left from the preceding suture and the ends cut short.

This third suture passes through all coats, and at the far end, after being tied, its end is knotted to the long end of the distal part of the previous second line of suture. This completes the fixing and hæmostatic layer of

suturing, which completely surrounds the stoma (aperture between the viscera) and is knotted at two opposite points of the circumference. The peritoneal layer is only complete at the back, so a fourth layer is inserted, this time of fine silk, beginning again at the left and tying the free end after knotting to the long end left after the first silk suture was tied : this suture is carried along, taking up peritoneum, and buries the preceding apposing layer of chromic catgut ; on reaching the end it is tied and the free end again tied to the far end of the original silk suture. A reinforcing suture may be inserted at each end of the suture-line to fix the viscera more
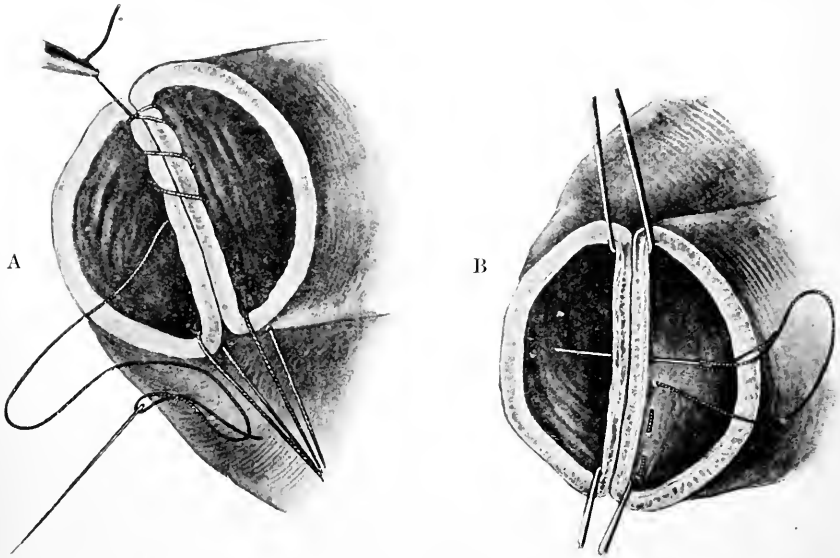

Fig. 38.   Methods of passing sutures to unite intestine.   A, The ordinary overhand suture.   B, Connell's or glover's suture : this last secures more perfect inversion of the gut wall, but takes more time to insert and is not ended if an external peritoneal layer of sutures be employed.

securely, and the anastomosis is complete, having an external suture-line of silk and an internal one of chromic gut, both complete.   There is no need to insert the apposing layer of chromic gut in the Connell manner, as the overhand method, though bringing mucosa against mucosa in the third line of suture, is perfectly satisfactory in practice and takes less time to insert.   The sutures, as to spacing, are placed about five to the inch. For a short-circuiting operation the above is all that is done, but if the operation is to join the ends of intestine after a resection it will, of course, be necessary to close the ends as well, and this is usually done before the anastomosis is made and after resection is done, but lateral anastomosis may be a preliminary drainage operation in the milder forms of intestinal obstruction and the obstruction removed later.

The ends may be closed after the ordinary fashion for suturing intestine, *i.e.* a row of continuous chromic-gut sutures may be passed through all coats, followed by a second row of continuous silk invaginating and burying the former and making all snug and safe.   The larger viscera are best

closed in this manner, but the small intestine, if not too distended and hypertrophied, may be occluded as follows : The whole circumference is crushed transversely with a powerful clamp and then ligatured and cut across ; the ligatured part is then quickly invaginated with a purse-string suture. A similar plan is employed in amputating the appendix, and has the merit of speed and simplicity.

(3) *End-to-side Anastomosis.* Occasionally anastomosis is made by fixing the end of the smaller piece of intestine into the side of the larger. After obstructing the lumina with clamps as before, an aperture is made in the side of the larger portion of the same size as the end of the smaller piece, and suturing in two layers carried out on the same lines as for end-to-end anastomosis.

MECHANICAL DEVICES FOR PERFORMING ANASTOMOSIS. Innumerable bobbins, plates, forceps, and buttons have been devised in the last few years to facilitate and expedite the operations of entero-anastomosis. With the exception of the well-known button of Murphy they may all be dismissed as unnecessary and often useless. The former ingenious mechanism, though seldom needed, is occasionally of great value. The button consists of two halves, male and female, united by a spring-catch which can readily be forced together but only separated by unscrewing. On the male portion is a flange acted on by a spring, which crushes the two surfaces of gut between this and the female portion and thus causes pressure-atrophy, allowing the final escape of the button into and along the lumen of the intestine. Each half is inserted into the ends of the gut or into a hole cut in each portion to be anastomosed, and secured with a purse-string round the aperture or end of the intestine ; in the latter case care is needed that a good hold is obtained on the mesenteric attachment (best managed by taking a double turn around this). The larger part of the button is inside the lumen of the gut in either case, and the purse-string tied around the relatively narrow neck of the button, which is held with clip-forceps.

FIG. 39. Section through a lateral anastomosis of intestine, showing the position of sutures and knots in passing from the posterior layer of peritoneal suture at A, to the anterior layer at B.

Then, taking the halves one in each hand, the male part is run up into the female until the spring flange on the male portion jams firmly, securing firm coaptation of a wide area of the peritoneum of each part of the gut ; a few sutures may be added round the union to make it more secure. The part of the gut gripped between the flange and the female half sloughs out in a few days, but not until (in favourable cases) there is secure union of the two portions of gut. The button is passed per rectum as a rule in two to three weeks.

The advantages of the button are that it can be inserted more quickly than an anastomosis by suture can be made, but not a great deal, say five minutes for adjusting the button against twelve for performing anasto-
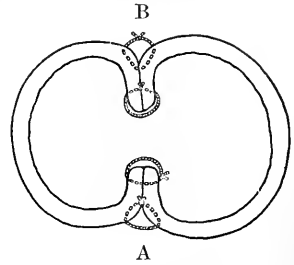
mosis by suture, and in cases where such a small difference in speed is
important it would be safer temporarily to drain the intestine than to perform
any sort of anastomosis. The chief advantage is that the button can be
applied in the depths, where a satisfactory anastomosis is almost, or quite,
an impossibility except with such expenditure of time as to put it out of the
question. Where the intestine can be brought to the surface the method
by suture is to be preferred.

INJURIES OF THE ABDOMEN AND ITS CONTENTS

These cases may be divided into : (1) those affecting the parietes only ;
(2) those affecting the parietes and the viscera, including gunshot injuries ;
(3) those concerning the viscera alone.

(1) Injuries to the parietes may be : (a) crushes and contusions ;
(b) wounds.

(a) In this group we find bruises from blows and wheel accidents,
ruptures of muscles from violent movement or tetanic convulsions.

Signs. A tender swelling, possibly with ecchymosis, while if a muscle
be ruptured there will be a gap of varying extent in its contour, especially
when it is put in action. The real importance of such injuries is to dis-
tinguish them from injuries of internal viscera which may be associated
with them, and the practical rule is : Any patient who has suffered from
considerable violence to the abdomen should be placed in bed and watched
carefully for signs of internal injury ; nor should there be any hesitation
to explore the abdomen where there is reasonable suspicion of such injury,
for early operation is the salvation of such patients.

Treatment. For simple contusions, rest in bed for one or more days,
followed by massage. Should a hæmatoma suppurate, the abscess should
be opened as usual. If a muscle be ruptured, this should be exposed and
sutured if extensive, but if slight, rest in bed for fourteen days with the
muscle relaxed, *e.g.* with the head and pelvis both raised if, as usually
occurs, it is the rectus abdominis which is torn.

(b) Wounds of the abdomen may be penetrating or non-penetrating ;
the former are considered in the next group.

Non-penetrating wounds are of little more significance here than else-
where, and simply require cleaning and suturing ; in the process of cleansing,
however, careful examination should be made, enlarging the wound if neces-
sary to make quite sure that they do not penetrate into the abdominal cavity.
Suturing should also be carefully performed, or hernia may later result.

(2) Penetrating wounds may be caused by stabs, impalements, bullets,
&c., and are recognized by :

(a) Protrusion of viscera when this occurs.

(b) Finding the aperture of penetration when cleansing an abdominal
wound.

(c) Shock, vomiting, and rigidity of the muscles around the injury,
suggesting a penetrating wound with involvement of some viscus or early
infection of the peritoneum.

Treatment. In all doubtful cases the wound should be enlarged so that there can be no doubt in the surgeon's mind as to whether or not the peritoneum has been opened ; the skin around is, of course, rendered sterile with iodine and all preparations made for an extensive laparotomy. Where the wound penetrates, if small, it should be enlarged and the neighbouring viscera examined. If viscera protrude, they should be washed with solution of biniodide of mercury 1 in 5000, and this washed off again with a normal saline solution before the viscus is returned. Omentum, however, if protruding, is best ligatured and excised. Injured viscera are treated as described in later sections and the abdominal wall closed completely unless infection be present already, when a drain-tube should be placed down to the site of injury. To put the matter concisely, where a penetrating wound is found we perform an exploratory laparotomy, since it is far safer to make the diagnosis by internal inspection than by waiting for the onset of signs of peritonitis.

GUNSHOT WOUNDS OF THE ABDOMEN. These fall into two main groups :

(*a*) Those caused by missiles of low velocity and some size, such as revolver-bullets or those of the older types of rifles and muskets, shot-gun and shell wounds.

(*b*) Those caused by bullets of modern rifles of high velocity and small calibre.

(*a*) Wounds of this sort are similar in character to other penetrating wounds of the abdomen and are treated as such, viz. carefully cleaned and examined, and if penetrating the abdomen in the vicinity explored, not primarily to search for the bullet but to examine for perforations of viscera and injuries of blood-vessels.

(*b*) Wounds caused by projectiles of high velocity and small calibre are different if the latter strike at close range (*i.e.* up to eight hundred yards or more for these weapons) ; the course is straight and a very small hole results ; nor does the bullet cause the disruptive and lacerating effect of larger missiles of lower velocity, and these wounds in the abdomen resemble rather the puncture of a small trochar than an ordinary wound. Such small holes in the stomach or intestine are readily plugged by the mucosa and sealed off by plastic lymph. The result has been that many patients with no more treatment than lying on the battlefield without food or drink for many hours (penitential, but salutary for the peritoneum) have recovered without any grave symptoms. And further, since operations at or near the firing line are conducted under unfavourable conditions, the results in military practice have been most satisfactory by simply placing a sterile dressing on the external wound and keeping the patient under small doses of morphia and practically starved for three to four days. This is undoubtedly the line to take in military practice and where the conditions for operating are unfavourable if the condition of the patient does not point to internal bleeding or extravasation of visceral contents ; but under other conditions or where such signs are present, and in all wounds caused by revolver and musket bullets, fragments of shell, &c., exploratory laparotomy

should be undertaken at the earliest possible moment and the surgeon be prepared for a large operation, as the gut may be penetrated in many places and need suturing, or excision of one or more portions of intestine or other viscera may be advisable.

Note. The most recent *pointed* small bore high-velocity military bullet frequently turns over in the tissues and causes much laceration of intestines. Hence exploratory laparotomy is advisable in all such cases where the surrounding condition of the patient's state permits it. For the results in the present war show that without operation bullet wounds of the abdomen are almost invariably fatal.

(3) Injuries of the Abdominal Viscera without Penetration of the Parietes. This class is important as offering more difficulties in diagnosis than the above-mentioned groups.

These lesions are usually caused by severe injuries, such as the passage of a cart-wheel over the belly, the kick of a horse, buffer accidents, &c. Very different degrees of damage result from such forms of blunt violence ; there may be slight bruising of stomach and intestine, ecchymosis into the retro-peritoneal tissues, rupture of hollow viscera with extravasation of fæces or urine, rupture of solid viscera (liver and spleen), or tearing of the mesentery with great effusion of blood.

Examination, Signs, and Diagnosis. As has been mentioned, all injuries of the abdomen where considerable violence has been used should be regarded with suspicion, even if the patient feels little amiss at first ; thus we have known a patient with ruptured intestine walk up to hospital, while another with a ruptured spleen went about his business for some hours till the faintness he experienced caused him to seek relief.

On the other hand, slight violence may produce severe shock, particularly when the blow falls on the epigastrium or " mark " of boxers. Blows on this region produce considerable collapse, doubtless from vagus inhibition of the heart from the stomach, which is exposed in this area ; occasionally such cases have proved fatal. A patient suffering from abdominal injury should be kept warm in bed to counteract shock, but morphia should not be given before a diagnosis is made. The urine should be obtained naturally or by catheter, and should it contain blood, the bladder and kidneys are further investigated to find out the source of bleeding (*see* Injuries of the Kidney and Bladder). The rectum is examined for tearing or bleeding. Failing any evidence of damage in these quarters, there are two conditions to be considered as calling for immediate operation, viz. (1) internal hæmorrhage, (2) rupture of a hollow viscus with extravasation causing peritoneal irritation and peritonitis.

(1) The signs of internal bleeding may be briefly recapitulated : pallor ; breathlessness and air-hunger, with sighing respiration ; great thirst ; syncope ; failure of sight and hearing ; a small, rapid pulse of very low tension (it should be noted, however, that the pulse at first is not very rapid but of low tension ; a rapid pulse means that much blood has been lost and efficient treatment is urgently needed).

Locally there may be shifting dullness in one or both loins. The blood from a ruptured liver is directed by the root of the mesentery into the right, and from the spleen into the left, loin ; in either case blood finally pours into the pelvis and may be felt per rectum as a soft, bulging mass. Bruising of the skin may give a clue to the site of deeper injury.

(2) Signs of a ruptured, hollow viscus are shock and a gradually rising pulse-rate with local rigidity and tenderness of the abdominal wall, which later becomes generalized with tympanitic distension. Possibly there may be some localizing signs, as blood-stained vomit from an injured stomach, hæmaturia from the urinary tract, or blood from the rectum where the lower intestine is the seat of lesion. Percussion of the abdomen may be of assistance. Loss of liver dullness while the abdomen is rigid and not distended suggests escape of free gas into the peritoneum from rupture of stomach or intestine ; if there be loss of liver dullness with rigidity and distension of the abdomen it means that peritonitis is already advancing, and the prognosis is grave ; tympanitic distension without rigidity or tenderness is often due to atony of the gut in consequence of hæmorrhage into the retro-peritoneal tissue and pressure on the mesenteric nerves with no gross lesion of viscera.

FIG. 40. Section showing the position of sutures in closing an aperture in the intestine. A, Through-and-through suture. B, Peritoneal suture.

Treatment. Cases demanding immediate operation are : (1) Cases of internal bleeding (injuries of liver, spleen, mesentery) ; (2) where much blood is vomited or passed per rectum, with abdominal tenderness and rigidity ; (3) injuries to the kidney and bladder (*see later*) ; (4) where the abdomen is rigid and tender while the pulse-rate (taken every quarter of an hour) does not fall but tends to rise, especially if there is loss of liver dullness and severe shock.

The practical rule is, When in doubt open the abdomen and look ! for diagnosis is often difficult, and it is a far less serious error to perform laparotomy where there is simply shock and some retroperitoneal bleeding than to wait too long before operating on cases of ruptured intestine. Early operation is the only means of saving these very serious cases, and the bad results hitherto attained are partly due to an over-expectant attitude on the part of surgeons. To counteract shock, saline fluid is given intravenously or per rectum while the exploration is being made.
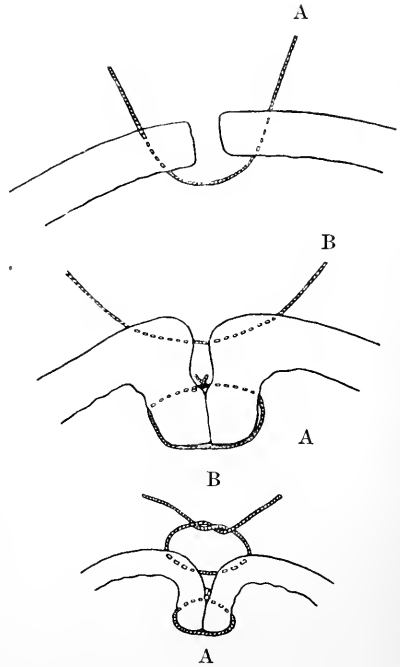
Operation. The signs and position of superficial lesions may give a clue
to the best place for opening the abdomen, but in many early cases it will
be uncertain whether the condition is one of internal bleeding or ruptured
viscus. Where the signs clearly point to internal bleeding the abdomen
should be opened by a paramedial incision above the umbilicus, so that
the liver and spleen, and if necessary the kidneys, may be explored (there
may be no hæmaturia in severe injuries to the kidney). The opening
should be free ; exploration through a finger-hole is of little service. The
nature of the case is usually clear on opening the abdomen, gas and intes-
tinal contents or pure blood showing the sort of organ which has been
ruptured. When large effusion of blood is the guide the liver and spleen
are palpated all over, and if no lesions are found the kidney is palpated ; then
the omentum and mesentery should be searched, sponging blood away and
carefully looking for its origin. In a similar manner intestinal contents,
bile, or urine will lead to the site of lesion, and care is needed not to miss
an important lesion where more than one is present ; thus there may be
rupture of hollow viscus with severe internal bleeding from torn mesentery.
The methods of dealing with injuries of the various organs will be described
under the appropriate sections.

AFFECTIONS OF THE PERITONEUM

Like other endothelial membranes, the peritoneum is prone to become
inflamed under the action of irritants ; its endothelium proliferates and
pours out an exudate, lymph, which may become absorbed, break down
into pus or become organized into fibrous tissue. The results of this inflam-
mation, " peritonitis," are of far-reaching importance to the patient both
for good and evil.

PERITONITIS. *Etiology.* The causes of peritonitis are :

(1) Simple or non-infective.

(2) Infective or microbic.

(1) Any foreign body, with but few exceptions (such as oily substances,
e.g. vaseline), when in contact with the peritoneum produces inflammation.
The surgeon is often responsible when he introduces sutures, gauze, tubes,
&c. Interference with the blood-supply, such as ligaturing or twisting
of omentum or ovarian cysts, produces similar changes. Such inflammation
is always of the plastic, reparative, and localized variety at its com-
mencement, and is essentially protective. Nevertheless the exudate
thus produced forms a suitable ground for the growth of pathogenic
organisms, and hence such an inflammation may become secondarily
infective and spreading owing to invasion by organisms from (for
example), the neighbouring intestine, as often happens in twisted ovarian
cysts.

(2) By far the larger number of cases of peritonitis, or at any rate of
peritonitis which causes symptoms (plastic, non-infective peritonitis is
usually symptomless unless the adhesions produced cause trouble), are due
to bacterial infection.

There are three main paths of bacterial infection :

(1) *By the Blood-stream.* Tubercle bacilli and pneumococci enter in this manner, as do also streptococci in cases of peritonitis found in a general infection (pyæmia).

(2) The commonest route is from the adjoining abdominal viscera. Thus in the alimentary tract and its diverticula we find infection from gastric ulcer, biliary infections, ulcers and obstruction of the small intestine, appen-dicitis, &c. The genital tract in the female affords notable examples in puerperal and pelvic peritonitis. The organisms most often responsible in this condition are the colon bacillus and the streptococcus, while the gonococcus is occasionally found.

(3) Infection from wounds involving the peritoneum, rarely from surgical intervention since the modern advance in asepsis.

The causative organisms found are streptococci, colon bacilli and their congeners, gonococci, pneumococci, and the tubercle bacillus.

Clinical Varieties. Peritonitis from a clinical aspect may be divided into acute and chronic varieties, the latter being principally due to infection with the tubercle bacillus.

ACUTE PERITONITIS. This may be divided clinically into three main divisions, while from the nature of the infecting organism further distinctions may be made, which are mentioned later. The clinical varieties (which are chiefly due to colonic and streptococcal infections) are :

(1) Diffuse or general peritonitis,
(2) Localized but diffusing peritonitis, *i.e.* with a } Acute spreading
tendency to spread, } peritonitis.

(3) Localized and circumscribed, *i.e.* with little tendency to spread, but rather to remain for some time as an intraperitoneal abscess.

It should be noted that the first two varieties are closely allied, the first being a more advanced condition of the second, and further, that clinically and at operations cases are often regarded as of " general peritonitis " when they are really only a very diffuse local form with a spreading tendency.

Anatomy. The peritoneum becomes congested and red, and later loses its gloss from desquamation of the endothelium and exudation of serum and lymph, as well as œdema of the membrane itself. At the same time the intestines become distended and paretic from the poison introduced by the infecting agent. In very severe cases the redness and distension rapidly spread over the larger part of the peritoneal surface, the amount of exuda-tion being but slight. Such cases are often due to streptococcal infection, and are likely to be fatal within one or two days. Puerperal peritonitis is apt to take this form.

More commonly, however, effusion is a notable feature of the pathological anatomy—thick plastic lymph, serum, sero-pus, and thick pus being found in different parts. The lymph is protective and localizing, showing victory of the defensive mechanisms over the infective organism, the presence of pus showing that the organisms are getting the upper hand and are breaking down and digesting the protective lymph. The pus and serum collect in

the peritoneal pouches, in the pelvis, and in loculi formed by the sticking of coils of intestine together with lymph. In some instances the effusion may be hæmorrhagic or putrid and bubbling with gas. This effusion is often highly infective, and the surgeon should be careful not to wound his fingers whilst operating on such patients.

(1) Where the infection is diffuse or general (the latter is not a very good term as peritonitis is seldom spread throughout the whole cavity, the lesser sac at any rate often escaping) there is often but little effusion but simply congested peritoneum and greatly distended intestine, which gradually alters in colour from red to purple and grey as the circulation becomes more impeded.

(2) Where the process is localized by plastic lymph, which, however, is breaking down, the condition may well be called diffusing. In such cases there will be a thin, turbid exudate of large extent, while inside the part walled off there will be a collection of pus which is often most offensive.

(3) Where the infection is localized there is a firm wall of lymph around the original focus of suppurative peritonitis which acts as a barrier and tends to become organized into fibrous tissue. When this has taken place there is some chance of the infective material being destroyed and absorbed by the tissues and the abscess replaced by fibrous tissue. It is with this hope that some surgeons leave cases of acute appendicitis to " quiet down," but there is always considerable risk of such a localized abscess acquiring further virulence and spreading again or bursting into the general peritoneum.

Signs of Diffuse and Diffusing Peritonitis (acute spreading). These are similar in the different forms but more acute and urgent in the diffuse and diffusing varieties, to which this description especially applies.

The onset is as a rule sudden, with pain in the abdomen and often vomiting. The pain is at first in the region of the umbilicus, and then passes to the part of the abdomen most affected, *e.g.* the right iliac fossa when originating in the appendix, the right hypochondrium when the gall-bladder is the initial focus. It is important to recognize that peritonitis is usually localized in its earlier stages and may readily be checked by suitable operative measures. The abdominal wall will be very tender and held rigid at the site of the lesion or, when the latter is diffuse, all over (these are the crucial signs of early peritonitis). As the disease progresses the abdomen becomes distended, does not move on respiration, and is resonant on percussion (tympanites) ; later, if there is much effusion, shifting dullness in the flanks will be noted. In advanced cases the arms are held over the head, the knees are flexed, the respiration is shallow and entirely thoracic (in order to diminish the intra-abdominal tension and movement of the wall, which are intolerably painful).

Fever is usual, but in very severe cases may be absent throughout, and the temperature tends to fall when the toxæmia is grave.

The pulse is rapid, of small volume, and at first of high tension or, as it is called, " wiry " ; later, with general failure, the tension becomes low

or " thready." The tongue is furred and dirty in the less severe stages, but in diffuse peritonitis is dry, brown and cracked, resembling a piece of toast.

Vomiting is a marked feature as the condition spreads, being first of stomach contents, then green from admixture of bile, and later brown and fæculent from evacuation of the putrefying material in the over-distended intestine. The act of vomiting is with little effort on account of the pain involved in straining. Constipation is marked and in the later stages is absolute, *i.e.* no flatus is passed owing to the paralysis of the intestine. The facial appearance of a patient suffering from diffuse peritonitis is characteristic but found in other acute forms of abdominal disease, such as intestinal obstruction. The eyes are sunken and hollow and the expression anxious and careworn. Later, with impending death, the " facies Hippocratica " becomes evident, the expression being more drawn, the eyes dull, the face pinched, the lips leaden in hue, the cheeks and nose blanched and cold.

Where the peritonitis is localized the tenderness and rigidity are also confined to some part of the abdomen, and the general signs—vomiting, constipation, and rapidity of the pulse— are less marked or absent, while the facies never assume the complete Hippocratic type. As the inflammation becomes more circumscribed the local resistance of the abdomen gives place to a definite swelling or lump which may be but slightly tender, and the parietes over this may offer but little resistance to palpation. Such a lump may consist of omentum and intestine matted together by lymph, but if of any size usually contains pus as well and is, in fact, a localized intra-peritoneal abscess.

Diagnosis of the " acute abdomen." Acute affections of the abdomen demanding immediate surgical interference, or, as they are often called, conditions of " acute abdomen," fall into three main groups : (*a*) the obstructive, (*b*) the peritonitic, (*c*) internal hæmorrhage. (*See also* p. 233.)

Intestinal obstruction and peritonitis (including under this term such different conditions as the results of appendicitis, perforation of gastric, duodenal and typhoid ulcers, acute pancreatitis, twisting of ovarian cysts, &c.) have many signs in common ; nor is this surprising when we consider that peritonitis is a cause of intestinal obstruction owing to paralysis of the poisoned gut. In both these conditions there are vomiting, constipation, and grave general disturbance, as shown by the pulse, tongue, respiration, and facies. The great difference lies in the tonus of the abdominal wall, which is rigid and tender in peritonitis, but in obstruction flaccid and not tender except in the later stages ; while the pain, which is constant in peritonitis, is very often paroxysmal in obstruction. Amongst cases of intestinal obstruction rigidity is only found early when there is a volvulus, and here there is great distension and tympanites. In peritonitis rigidity and tenderness come on at once, but in obstruction only when there is considerable distension and usually due to peritonitis secondary to the obstruction. Internal hæmorrhage, if massive, is clearly distinguished by

the pallor, breathlessness and syncope, but in cases where the amount of blood effused is not very great the clot causes irritation and a mild form of peritonitis which can hardly be distinguished from other forms of sub-acute peritonitis.

The above conditions practically always require operative treatment, and mistaking one for the other is not of so much moment to the patient, though humbling to the pride of the diagnostician. There are in addition certain affections which do not require operation, to be distinguished from the symptom-complex known as the " acute abdomen," and these may arise in the abdomen or thorax. Abdominal affections to be distinguished from peritonitis are colic, neuroses and nervous disease, gastro-enteritis.

By *colic* is meant a spasm of unstriped muscle associated with intense pain and coming on in cramp-like paroxysms ; this may affect the stomach or intestine (due to improper diet, duodenal ulcer, lead-poisoning, tabes, and entero-spasm, which is a pure neurosis of the intestine of unknown origin), the bile-passages or ureters (from passage of calculi, &c., as detailed in their respective sections). The pain of colic is distinguished from that of peritonitis in being paroxysmal, abating almost entirely between the attacks. It is often associated with rigidity, but this passes off with the attack of pain ; nor is the abdomen tender on deep pressure as in peritonitis. The pain of colic is far more severe than that of peritonitis and the consti-tutional signs less severe, the pain often radiating in a special manner (in biliary colic to the right shoulder, in renal colic to the leg, testis, and groin).

It must be fully realized that where intestinal obstruction is coming on rather gradually the pain is often paroxysmal ; in other words, one cause of colic is obstruction of the bowel, and therefore where repeated attacks of colic occur which are not of renal or biliary origin or due to tabes or lead-poisoning, exploratory laparotomy is indicated.

Gastro-enteritis may, when ultra-acute, present some resemblance to peritonitis, since diarrhœa is found in severe cases of the latter affection and collapse with vomiting is characteristic of both disorders. The absence of rigidity of the abdomen and the subnormal temperature in gastro-enteritis will as a rule make the diagnosis clear.

Of thoracic disease, that most likely to be confused with peritonitis is acute lobar pneumonia. The sudden onset, with vomiting, constipation and pyrexia, is similar, and when it is remembered that the intercostal nerves not only supply the pleura and intercostals but also the peri-toneum and abdominal muscles, it will be readily understood how the pain and irritation of an inflamed pleura may be referred to the abdomen, which is held rigid and is tender on deep palpation. The facies and respir-ation, however, are different. In pneumonia the respiration is far more rapid, being about half as fast as the pulse, and is more laboured, while the flushed face, bright eye, and working alæ nasi form a very different picture to the dull eye, and anxious, pinched face found in acute abdominal disease. The fever is usually higher in pneumonia ; 103° is high for peritonitis, while 104° is moderate for pneumonia.

More difficulty is experienced when peritonitis and pneumonia occur together, as when pneumococcal peritonitis follows quickly on pneumonia or where appendical peritonitis leads to secondary pneumonia.

The enlarged, tender liver associated with heart-failure must not be mistaken for peritonitis of the upper abdomen. The irregular pulse, breathlessness, œdema of the legs, and scanty urine will serve to distinguish, but as we have seen this error made on more than one occasion it seems worth recording.

Prognosis. This depends on the virulence of the infection, the extent to which this is diffused, and on whether adequate treatment can be and is carried out. Infection with streptococci or pneumococci is always grave and in some cases hopeless ; coli infections are less lethal, and gonococcal by comparison relatively mild. Naturally the larger the extent of peritoneum involved the worse the prognosis, but here again the quality of the infection makes a great difference. Thus there may be widely diffused peritonitis from perforation of gastric or duodenal ulcer, the peritoneum being red and the intestines distended over a very large part of their extent, yet the prognosis is tolerably good if the case is operated on early and the perforation adequately sutured ; whereas a similar case secondary to appendicitis will almost surely die. The best indications for prognosis are the general condition of the patient, notably the pulse and facies ; if these are favourable and the local lesion can be dealt with we can have a fair hope of success, however widespread the affection and whatever the infecting organism. A small, thready pulse of 130° and upwards, a Hippocratic face, distended abdomen, and cold extremities mean disaster in almost every case.

Peritonitis is almost always a localized affection at the outset, and for treatment to be successful it must be dealt with while still localized and before a wide spread has lowered the patient's resistance. Early diagnosis and speedy operation are the main factors in the treatment, as is well shown by the excellent results of operations for perforative lesions. The practitioner's aim should be never to allow peritonitis to become diffused. This is not always possible, but early diagnosis and operation make this more often feasible. Unless the patient is moribund exploratory laparotomy is nearly always advisable.

Treatment. As mentioned, peritonitis is usually localized at first and should be dealt with before it spreads. It is important to diagnose the locality of the peritonitis rather than the organ affected. Thus it matters little whether peritonitis originates from an appendicitis, a salpingitis, or perforation of a typhoid ulcer ; the important matter is to recognize early that there is peritonitis in the lower right quadrant of the abdomen and advise immediate operation ; similarly, in the upper abdomen the stomach, duodenum, or gall-bladder may be the source, but the thing to recognize is early localized peritonitis. In doubtful cases it is well to explore the appendix either by a muscle-splitting incision or a paramedial incision, displacing the rectus inwards ; the character of the fluid inside the peri-

toneum will often give a clue to the nature of the lesion (*see below*), while the appendix, lower ileum, and Fallopian tubes may be explored through this incision. It is always sound policy to examine the appendix as it is so often the point of origin, and this examination takes but little time, while the incision made serves very well to drain the pelvis, if this be needed for lesions in the upper abdomen. Where lymph is found it may be traced in the direction where it is thicker, thus leading to the main focus of disease. This focus will consist of an acutely inflamed or possibly gangrenous organ, as the appendix or gall-bladder, or perforation of some hollow viscus. The affected part is removed or sutured according to its nature, the main object of the operation being to remove or sequestrate the primary focus.

NATURE OF FLUID, ETC., FOUND IN THE PERITONEAL CAVITY. This will often give a clue to the part affected.

(1) Blood suggests a ruptured ectopic gestation, ruptured ovary, or a twisted ovarian cyst in women, while in either sex it may be the result of acutely strangulated intestine, malignant growth, acute pancreatitis, or lacerating injury.

(2) Excess of clear fluid is found in cases of strangulation of intestine and also in the neighbourhood of acute inflammation, such as an appendix abscess ; also in tuberculosis of the peritoneum, ascites, &c.

(3) Thin, turbid fluid is found in the vicinity of inflammation or abscess which is not well circumscribed. If yellowish, perforation of an ulcer low down the small intestine (*e.g.* typhoid ulcer) is suggested ; if opalescent, perforation of the duodenum ; if acid-smelling and with particles of food, perforation of the stomach ; while in the last three conditions a whiff of free gas often escapes as the peritoneal cavity is opened.

(4) Thick pus, if odourless, is likely to be pneumococcal, occasionally of gonococcal origin ; while thick, foul-smelling pus is usually of appendicular origin or from perforation of the large intestine.

Where the character of the exudate or the distribution of the lymph suggests a focus in the upper abdomen a second incision is made to suit.

In another class of case there will be a localized abscess with well-defined swelling felt in the abdomen or per rectum ; such conditions are discussed later (*see* Localized Peritonitis and Intraperitoneal Abscess).

In cases where the infection is all over the peritoneum and there is little effusion, especially when of blood-borne origin and not from a local focus (*e.g.* streptococcal or pneumococcal), operations are of little use. Nevertheless in most of these conditions, if the patient can stand the operation, the abdomen should be opened, since we can seldom be sure beforehand that there is not a local cause, *e.g.* appendicitis, and unless this be removed recovery is improbable.

Technique. All cases of peritonitis should be placed in the semi-recumbent, " Fowler position " while the details of operation are being arranged, and fluid and food by mouth is stopped and saline per rectum given. In all severe cases intraspinal anæsthesia is advisable. The operation should be quickly performed, the operator doing what is necessary with the utmost

dispatch compatible with sound work. The intestines are handled as little as possible, pus, when present, gently but rapidly sponged out ; irrigation is inadmissible in most cases, only adding to the danger by spreading infection, prolonging the operation, and cooling down the surface of the patient to an unpardonable extent. The initial focus is dealt with as described under Appendicitis, Perforated Gastric Ulcer, &c., and the abdomen closed.

Drainage. Where all pus and exudate is removed but little drainage is needed and depends on the nature of the infection. Thus in peritonitis following appendicitis it is advisable to drain if pus has been found, but if the quantity is small a very small tube may be used and removed after two days. After perforations of the stomach with but slight and local effusion, drainage may be omitted ; if considerable, a good-sized tube in the recto-vesical pouch will drain off fluid for about three days, after which it may be removed. A localized abscess containing foul pus should be drained with a large tube for three to four days where the focus of origin has been removed, and longer where this has not been achieved. After four days the tube may be shortened so that it just traverses the abdominal wall, as if a tube be kept long amongst the intestines it will often lead to a persistent sinus or perforation of intestine and fæcal fistula. Where there is little or no exudation and no local focus, drainage of the peritoneal cavity is useless and the outlook is usually bad. In such cases where the intestines are much distended it is worth opening and draining the latter : a better plan is to puncture the gut with a medium trochar in several places, removing the putrefying contents and closing each puncture with a purse-string suture. This may diminish the toxic absorption and be of some assistance.

After-treatment. After operation the patient should be placed again in Fowler's position as soon as there is no danger that this position will cause collapse, in order that the effusion may gravitate into the pelvis and not infect the pouches round the liver. Attempts should be made to raise the blood-pressure by administering saline infusion either into the veins or, better because more slowly, into the rectum or subcutaneously. This is needed (a) to diminish shock, (b) to increase the renal secretion and help in the elimination of toxines, and (c) to increase the effusion of serum containing anti-bodies into the peritoneum.

The bowels are made to act by doses of calomel, one grain hourly for six doses, followed by enemata of turpentine or valerian, while strychnine in $\frac{1}{30}$-grain doses is given every four hours to promote passage of flatus. It is very important to reduce the distension of the intestines by the use of turpentine, enemata, &c., as the bowels, if distended beyond a certain degree, become atonic and cannot recover. Pituitary extract in doses of a cubic centimetre given four-hourly has sometimes an excellent result in opening the bowels of these patients, but its action is uncertain. Eserine salicylate, $\frac{1}{200}$ grain, is also used but is very depressing and sometimes patients treated with this drug die of diarrhœa. Morphia should be given where there is much shock and the patient is restless.

SPECIAL VARIETIES OF ACUTE SPREADING PERITONITIS. *Pneomococcal Peritonitis.* This occurs as a primary infection or may be secondary to infection of the lung, appendix, Fallopian tube, &c. ; it occurs most commonly in female children, comes on acutely, and may be circumscribed or diffuse.

When starting in the lower abdomen the onset is very like that of appendicitis but less painful and apparently less severe, so that a large abscess may form in the abdomen. On exploration the pus is thick, yellowish and odourless, containing many large masses of fibrin and closely resembling the pus from a pneumococcal empyema. Wasting and diarrhœa are features of the more protracted cases. The prognosis is very bad, few cases of the diffuse variety surviving ; when circumscribed the outlook is better.

Treatment. Diagnosis is seldom possible before the abdomen is opened, and when a local abscess is present it should be drained.

Gonococcal Peritonitis. This occurs in women by extension from the uterus and tubes, and may be confined to the peritoneum of the pelvic organs or spread to the general peritoneal cavity. The usual form presents the signs of lower-belly peritonitis in a patient with profuse gonorrhœal discharge—there being pain, tenderness, and rigidity of the lower abdomen and stiffening of the pelvic tissue felt per vaginam : vomiting and tympanites may occur in severe cases. The treatment consists of rest in bed, keeping the bowels open and applying fomentations to the lower abdomen, and giving hot, antiseptic vaginal douches. Should the signs not abate or become more severe, as shown by rising pulse-rate, vomiting, &c., the abdomen should be opened, pus removed by sponging, and any focus of disease in the pelvis, *e.g.* a pyosalpinx, removed, establishing drainage per vaginam for a few days.

LOCALIZED OR ENCYSTED PERITONITIS, INTRAPERITONEAL ABSCESS. It has been mentioned already that peritonitis may be localized to some parts of the abdomen if the formation of fibrous tissue at the periphery is faster than the destruction inside the abscess, and this is assisted by the division of the peritoneal cavity into pouches or compartments by the mesentery, transverse colon, and omenta. Considered in this way intraperitoneal abscesses show something of an anatomical distribution, and some of the peritoneal pouches are sufficiently definite to merit a special description.

Peritoneal Pouches. (1) Below and to the left of the root of the mesentery is a space which is the lowest compartment of the abdomen and is continuous over the promontory of the sacrum with the pelvis. A collection of the pus in this region tends to collect in the pelvis, and may be roofed over by coils of intestine or may, if growing rapidly, extend up till it is limited by the root of the mesentery. A collection of pus in this compartment is called pelvic abscess, although it may reach a good deal above the true pelvis, especially on the left. (Fig. 41 (5)).

(2) Between the transverse mesocolon above, the ascending colon on the right, and the mesentery below and on the left, is another compartment normally filled by the small intestine. Where pus forms in this position

it tends to be segregated into loculi by adhesions and not to form a definite single abscess. (Fig. 41 (4).)

(3) Above the transverse mesocolon is a large compartment containing the liver, stomach and spleen, which is further subdivided by the ligaments of the liver, and it is especially to this compartment that we wish to draw attention, for it is here that the important condition known as subphrenic abscess is found. (Fig. 41 (1, 2, 3)). The two former conditions may be more briefly dismissed.

(1) *Pelvic Abscess.* As has been mentioned, this is situated in the space extending from the bottom of the pouch of Douglas or the retro-vesical pouch to the top of the pelvis, or possibly to lower border of the mesentery, being roofed over by the latter, the small intestine, or great omentum.

This form of abscess most commonly is consecutive to appendicitis, whether the latter is pelvic in position or from gravitation when the organ is elsewhere, but may follow any form of peritonitis where the Fowler position is employed ; and if an abscess must form anywhere this is the best place, being readily drained and the peritoneum being more resistant to infection than elsewhere. Hence after operations for suppurative lesions inside the abdomen, if the course is not satisfactory, examination is made for pelvic abscess, the indications being irregular pyrexia, vomiting, and distension of the abdomen. The signs of pelvic abscess are those of a mild degree of peritonitis with perhaps some resistance

Fig. 41.   Diagram of the main peritoneal pouches. 1, Subphrenic pouch. 2, Sub-hepatic pouch communicating through the foramen of Winslow (arrow) with 3, The lesser sac. 4, Pouch below the transverse mesocolon. 5, Pouch below the mesentery continuous with the pelvic cavity.

and tenderness of the lower abdomen, but examining the rectum reveals a tender mass in the pelvis which will often be found to fluctuate. The importance of rectal examination in obscure abdominal cases, or where after abdominal operations progress is not satisfactory, cannot be too strongly urged, for pelvic abscesses are common and present but slight signs on ordinary abdominal examination.

Treatment. Where the condition is found at the onset of the disease, *e.g.* associated with appendicitis, the abdomen should be opened and the cause treated (which usually implies removal of the appendix). Drainage through the abdominal incision, the tube passing to the bottom of the pelvic pouch, will generally suffice. Where the abscess occurs secondary to some abdominal operation and the focus of origin has already been treated
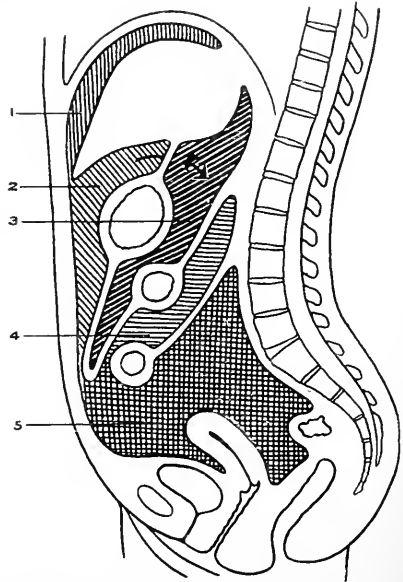
drainage alone will be needed. In women a tube inserted through the posterior fornix of the vagina into Douglas's pouch gives the most efficient drainage, but in males an incision above the pubes : drainage through the rectum is not to be recommended, as the tube irritates the latter and after removal of the tube the pus cannot readily escape on account of the sphincter ani, while faeces pass into the fistula, causing delayed healing.

(2) *Localized abscess* above the mesentery and below the mesocolon is usually the result of acute appendicitis, and consists of one or more loculi amongst the coils of small intestine and omentum.

The diagnosis is made by finding a resistant, tender and possibly fluctuating mass in the mid-abdominal region or right iliac fossa, with a history and symptoms pointing to peritonitis.

Treatment. The abscess is explored, usually through a muscle-splitting incision, and drained ; if possible, the cause (appendix probably) removed.

(3) *Suppuration in the Upper Abdominal Pouch (Subphrenic Abscess).* The peritoneal pouch above the liver is divided into right and left halves by the falciform ligament and into anterior and posterior parts by the coronary and lateral ligaments ; further, on the right side the foramen of Winslow places the lesser sac of the peritoneum in communication ; and to make an account of suppuration about the liver complete, note must be taken of an extra-peritoneal space of loose areolar tissue, where suppuration readily takes place.

Adopting a part of the nomenclature given by Barnard, these spaces are as follows :

(a) *The Right Anterior Intraperitoneal Compartment.* This is in front and above the right lobe of the liver, bounded above by the diaphragm, below and behind by the liver, the coronary and right lateral ligament, to the left by the falciform ligament, while adhesions between the lower edge of the liver and the transverse colon and diaphragm close it in front and below. Suppuration in this space occurs secondary to appendicitis, liver-abscess, and perforations of gastric and duodenal ulcers, this being one of the common sites for suppuration below the diaphragm.   (Fig. 42 (1).)

(b) *The Right Posterior, Intraperitoneal Pouch* is the largest and most complicated, and is also known as the *subhepatic* and *right kidney pouch* because it is in part below the liver and in front of the right kidney.

Starting on the right, it is bounded in front by the liver and coronary ligament, behind by the diaphragm ; it then passes down to lie in front of the right kidney and below the liver (a prolongation runs down from this part along the outer side of the ascending colon and drains into the right iliac fossa and thence into the pelvis) ; it extends along below the liver, above the transverse colon in front of the gastrohepatic omentum, to reach the posterior aspect of the liver between the diaphragm and the left lateral ligament. This pouch is mostly infected from the appendix, and sometimes from the stomach or duodenum.

(c) *The Left Anterior Pouch*, sometimes called the perigastric or perisplenic pouch, is to the left of the falciform ligament, below the diaphragm,

and above the liver, stomach, and spleen. This pouch is commonly affected, and usually from perforations of gastric ulcers.

(*d*) *The Left Posterior Pouch* consists of the lesser sac of peritoneum and is seldom infected, usually from ulcers on the posterior surface of the stomach. It will be noted at once that the right kidney pouch with its branches is much the largest and that the two anterior pouches readily communicate with this over the edge of the liver or round the lateral ligaments. The lesser sac is more inclined to be shut off as the foramen of Winslow is small and easily occluded by adhesions at the point where this pouch communicates with the subhepatic pouch.

In our experience the position of abscesses does not so definitely follow the anatomical pouches as laid down by Barnard, but parts of two pouches
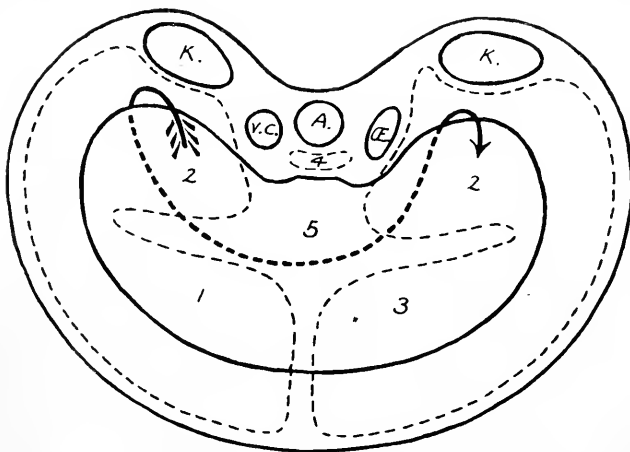
Fig. 42. Diagram of the upper surface of the liver, to show the various subphrenic pouches (after Barnard). A, Aorta. V.C., Vena cava. Œ, Œsophagus. K, Kidneys. 1, Right anterior pouch. 2, Right posterior or subhepatic pouch. (Note this appears on the left side also.) 3, Left anterior pouch. 4, Left posterior pouch or lesser sac. 5, Extraperitoneal position in the coronary ligament.

may be involved, or in the case of the large kidney pouch, part of this alone.

(*e*) The areolar tissue in the coronary ligament is fairly often affected, usually by spread of tropical abscess or suppuration of a hydatid cyst of the liver. Pus collecting in this space tends to come forward and spread the leaves of the falciform ligament and point at the front wall of the abdomen, where the ligament is attached.

The areolar tissue about one or other kidney is sometimes regarded as another position for subphrenic abscess, and in so far as the kidney is an inferior relation to the diaphragm the resulting perinephric abscess may be called " subphrenic," but as the causation and signs are for the most part different we treat of perinephric abscesses in the section on Surgery of the Kidney.

SIGNS OF SUBPHRENIC ABSCESS. The onset varies with the cause.

If arising from perforation of the stomach or duodenum the onset is

acute, in a patient suffering with dyspepsia (though this history may not be readily obtained) with signs of peritonitis in the upper abdomen, but of relatively mild degree as the effusion is localized. This is the surgeon's opportunity, and the patient should be operated on at once and the perforation closed, for the prognosis of suture for leaking ulcer with small effusion is much better than for drainage of a well-established subphrenic abscess. If this opportunity be missed the condition will quiet down to some degree and present signs of deep-seated suppuration in the upper abdomen, as described later.

Other cases are insidious in their origin, *e.g.* those starting from the leaking of a tropical abscess or suppurating hydatid of the liver.

Other cases, again, are found during the convalescence of a patient from suppurative peritonitis elsewhere, notably in cases of appendicitis where the Fowler position has not been adopted, and the pus therefore not forced by gravity to descend into the pelvis but can spread about the upper pouches (it may happen in spite of this precaution, but less often). Hence in such cases, when not doing well, it is essential to examine the lung bases and upper abdomen for subphrenic, as well as the rectum for pelvic abscess.

The general signs are as for localized peritonitis elsewhere : pyrexia, wasting, irregular constipation and diarrhœa, with pain and discomfort in the upper abdomen and increased rapidity of respiration.

Locally. The signs vary with the position and size of the abscess. When in one of the anterior pouches there will be rigidity of the epigastrium, abnormal dullness, with possibly a palpable lump projecting below the costal margin on that side. If the effusion be large the diaphragm may be displaced up, and with it the heart, but the dullness does not extend much below the normal dullness of the liver as its limit is fixed by adhesions, and for the same reason the mass does not move on respiration and so can be distinguished from enlargement of the liver : further, the heart, even if displaced upwards, is not pushed to one side as is the case with empyema, in which case also, as in subphrenic abscess, there is found dullness of the lung and loss of breath-sounds continuous with liver-dullness.

Where the right posterior or kidney pouch is affected the signs are less obvious as there is seldom an abdominal swelling. Resistance or dullness, however, are noted in the loin, where the abscess is of some size, and the dullness and loss of breath-sounds over the base of the right lung are well marked. This is to be distinguished from empyema by the heart not being displaced laterally, and breath-sounds are not so completely absent as in empyema. Radiographs may be of use, showing the displacement of the diaphragm up away from the liver : occasionally a tympanitic note, and the coin sound may be elicited in cases where there is gas in the abscess (pyopneumothorax subphrenicus) between the liver-dullness and the normal resonance of the lung.

Needling is the surest method of diagnosis, and this should be only employed when the patient is anæsthetized and the surgeon ready to finish

the operation right away, lest leakage round the needle should lead to peritonitis or empyema while the patient is waiting for the operation to be completed.   The needle should be introduced through the lower four or five costal spaces in turn, in line with the vertebral border of the scapula, and again outside this and to varying depths up to three inches, the piston of the syringe being pulled out while the point of the needle is at different depths.   When pus is found it is easy to see if it is above or below the diaphragm, for if below, the needle, being caught in the diaphragm, will move up and down with respiration.   Needling is especially necessary in the form of abscess, occurring in the subhepatic pouch.

When the abscess is in the lesser sac of the peritoneum there is a mass presenting above, below, or behind the stomach in which fluctuation may be detected ; having a close relation to the pancreas, such abscesses of the more chronic variety are sometimes called pancreatic pseudo-cysts.

When the infection is in the coronary ligament of the liver the latter organ is pushed down below the costal margin, and if the abscess be large the diaphragm will also be pushed up so that there are signs of compression of the right lung-base ; since the condition is extraperitoneal, there are no adhesions and the liver can still move on respiration to some extent. The wasting and apparent enlargement of the liver suggest malignant disease of the latter, but the irregular pyrexia and leucocytosis render the presence of suppuration likely, while radiographs will show the elevation of the diaphragm above the liver, and needling in the manner described will clear the matter up.

Treatment.   When the abscess projects beneath the costal margin it may be opened and drained in this position.   It is often advisable to open the abdomen by a paramedial incision to obtain a good idea of the relations and extent of the abscess, and, having closed this exploratory opening, to open the abscess where drainage will be most satisfactory, usually below the tip of the eleventh rib.   Where the abscess does not reach the costal margin it is best approached through the lower thorax, resecting a piece of the ninth, tenth, or eleventh rib, according to where the pus is found on needling, as when opening an empyema, and somewhere between the mid-axillary line and the vertebral border of the scapula.   The diaphragm is sutured to edges of the wound to avoid extravasation into the pleura, and the abscess then opened through the diaphragm and drained with a large tube ; of course, if an empyema is present as well, as sometimes is the case, this will be drained through the same incision.

Even with the most carefully planned operations the mortality is very high (30 to 50 per cent., according to the position), on account of the difficulty of draining all the pockets and because of the greater susceptibility of the upper peritoneum.   Prevention is far better, and this is possible in some instances by early operation on cases of localized peritonitis of the upper abdomen (as in leaking peptic ulcers, suppuration about the gall-bladder, &c.) and by adopting the Fowler position in all cases of peritonitis to prevent as far as possible the upward spread of peritonitis.

CHRONIC PERITONITIS. This occurs in two forms: (1) simple; (2) tuberculous.

(1) Simple peritonitis is the response of the peritoneum to various insults of non-infective nature, e.g. at the neck of hernial sacs from pressure, as the result of ligatures or sutures. This response is in the first place entirely reparative and beneficial. The organization and fibrosis, however, of such a benign peritonitis may lead to the formation of " bands " and " adhesions," which may cause pain by dragging or obstruction to the lumen of viscera. The clinical and pathological importance of this variety of peritonitis is purely secondary in nature, and will be discussed under Peritoneal Bands, &c., in the section on Intestinal Obstruction.

(2) *Tuberculous Peritonitis.* This is mostly found in young subjects, especially children, and may be the result of a blood-borne infection from distant parts, such as the lung or bronchial glands, or spread of infection from neighbouring parts, such as the intestine, mesenteric glands, Fallopian tubes, &c.

Anatomy. Miliary tubercles form in the peritoneum as they do elsewhere, and have the same tendency to progress in different directions, either breaking down, caseating and coalescing, or becoming converted into fibrous tissue where the resistance of the patient is greater, or causing a large effusion to be poured into the peritoneal cavity. In this way arise the different clinical varieties :

(a) In the *fibrous* type the tendency is toward healing by the formation of fibrous tissue. The parietal peritoneum becomes thickened, leading to difficulty in opening the abdomen at operation, which is further increased by the parietal peritoneum being adherent to subjacent viscera so that the peritoneal cavity is more or less obliterated. The intestines are adherent to each other and the omentum is infiltrated, thickened, and rolled into a sausage-like mass lying horizontally. Fibrous bands and cords frequently result, and there is considerable danger of intestinal obstruction arising from the latter.

(b) Where caseation is the predominating process we find the *ulcerative* type : there is a certain amount of fibrosis and matting of the viscera, but the spaces between the adhesions are filled with broken-down tuberculous material or caseous pus, i.e. there are intraperitoneal, cold abscesses, which may point on the surface or ulcerate into the intestine or both, with formation of a fæcal fistula. The superficial opening of such pointing abscesses is usually at the umbilicus. This variety is especially prone to a secondary infection with other bacteria from the intestine, causing formation of acute abscesses.

(c) In the *ascitic* type a large serous exudate is the most notable feature, there being little tendency to caseation and ulceration and not much to fibrosis. The inner surface of the peritoneum, both parietal and visceral, is covered with grey miliary tubercles, and the abdominal cavity is filled with a clear pale, straw-coloured fluid. In some instances fibrous adhesions do form, and then the fluid is loculated between adhesions and coils of intestine.

Signs. These are not well marked at first as the onset is usually insidious. Obscure abdominal pains, loss of appetite, irregular constipation, flatulence and general wasting, with some abdominal distension and dilated superficial veins on the abdomen in a child or young person with a family history or other signs of tubercle, will suggest this disease. In some instances the onset is almost acute with abdominal distension and pyrexia, suggesting enteric fever, but the absence of enlargement of the spleen, rose spots, bronchitis, and Widal reaction will serve to distinguish after a few days. These cases are sometimes mistaken for the " acute abdomen," and on the whole such mistakes are a healthy sign, for opening the abdomen is rather beneficial than the reverse in these cases, while early laparotomy may be the salvation of a case of acute appendicitis, with which the confusion generally arises. When the disease is more advanced the signs are more obvious.

Where effusion is a marked feature, in the " ascitic " type, there will be distension of the abdomen and shifting dullness in the flanks and lower abdomen. This evidence of free fluid in the peritoneum with irregular fever and wasting in a child will almost certainly be due to tuberculous peritonitis, as cirrhosis of the liver is uncommon in the young.

In the fibrous and ulcerative forms there will be noted irregular masses in the abdomen which are not removed by enemata (this test should be always applied) ; the rolled-up, thickened omentum forms a characteristic elongate mass across the upper abdomen, and localized areas of dullness with fluctation show the presence of cold abscesses. Irregular fever and wasting are well marked, while in the later stages diarrhœa is common, the fever assumes the hectic type, and there may be evidence of lardaceous disease. In a young person such a condition can be little else than tuberculous peritonitis, but in the middle-aged carcinomatosis of the peritoneum will present very similar features.

Prognosis. This is good in the fibrosing type except for the later possibility of intestinal obstruction arising from bands.

In the ascitic form, if but slowly advancing, the prognosis after operation is very fair, but if it comes on rapidly with much wasting and hectic fever there is probably considerable caseation and ulceration, and the outlook is poor. In the ulcerative form where fistulæ have formed, the prognosis is almost hopeless if diffuse, but where the condition is local and secondary to some localized intestinal or genital tuberculosis, *e.g.* of the Fallopian tube or hyperplastic tubercle of the colon with ulceration, excision holds out some hope of recovery. Recently, however, we have seen in a boy a case of the diffuse, ulcerative form with fæcal abscess followed by fæcal fistula, which cleared up in a few months, the fistula closing and but little signs of tuberculous peritonitis remaining as far as could be noted from abdominal examination. The course of tuberculosis is most uncertain.

Treatment. Little is needed in the fibrosing types except for the complications in the way of intestinal obstruction, but general tonic treatment as for all tuberculosis is advisable if the condition be suspected.

The milder cases of the ascitic variety are treated by rest, open air, sunlight, and overfeeding with fats and cod-liver oil. Mercurial dressings are often applied to the abdomen ; they are harmless. Where there is much effusion which is not appearing over-rapidly, much good is achieved by simple laparotomy and evacuation of the fluid. The fluid secreted to take the place of that removed contains a larger supply of anti-bodies and so has a curative effect on the tubercles—at least this is the theoretical explanation commonly given ; the practice is good.

Ascitic cases of the more acute sort derive but short benefit from laparotomy and are in truth of rather the ulcerative type : such should not be operated on with too much readiness, as there is much risk of the wound becoming infected with tubercle bacilli and breaking down, possibly with formation of a faecal fistula. The ulcerative forms should not be operated on unless there is reason to suspect that the affection is localized as in the conditions mentioned above, which may be found in adults but are rare in children.

PERITONEAL EFFUSIONS. Besides inflammations there are other causes of exudation into the peritoneum, of which carcinomatosis and ascites demand mention.

Carcinomatosis Peritonei. This is a secondary invasion of the peritoneum with cancer, usually of the abdominal viscera, stomach, intestines, uterus, and also the breast. This is for the most part an indication that surgical interference is out of the question. The fluid exudate is often large in amount and sometimes blood-stained, while on palpation masses of growth can be felt scattered about in the omentum, intestine, &c.

The inner surface of the peritoneum is covered with small nodules and masses which resemble tubercles but are larger and tend to break down with haemorrhages in their interior, and do not caseate like the masses in tuberculosis. In other respects the condition resembles that of tuberculous peritonitis, except that it occurs in middle-aged persons and pyrexia is absent or slight. Operative interference is only justifiable when intestinal obstruction supervenes, as not infrequently occurs from the concomitant adherence, fibrosis, and contraction of the peritoneum.

Ascites. This variety of peritoneal effusion is usually due to obstruction of the venous return from the abdominal blood-vessels, and may be regarded as passive oedema of the peritoneum, while the inflammatory exudates are active. Ascites may be due to the back pressure of a failing heart or from cirrhosis of the liver, or be part of the general anasarca of renal disease ; while in rare instances it results from blocking of the main lymphatic trunk, the thoracic duct, in which case the effusion is milky from admixture of chyle (chylous ascites). The signs of ascites are shifting dullness in the flanks and hypogastrium with resonance of the central part of the abdomen from the floated-up intestine present there. The belly is distended and in marked cases egg-shaped. A " fluid thrill " is obtained by placing a hand on one of the flanks and sharply flicking the opposite flank with a finger of the other hand ; where fluid is present a sharp rap is

felt with the palpating hand, which is quite characteristic of the presence of a mass of fluid.

Treatment. This belongs in most instances to the physician, who takes measures to promote the activities of the heart, kidney and intestines, and if the ascites be massive and embarrassing the respiration taps the abdomen with a fine trochar. In cases where the affection is due to cirrhosis of the liver surgical measures may be of service. The return of the venous blood from the portal system being obstructed by the contraction of the liver and its vessels, if an anastomosis can be formed between the vessels of the portal system and those of the parietes the blood will return in part by the latter channels, and so the congestion of the portal tract will be diminished and ascites relieved. Cases suitable for this operation are those in which ascites is of short-standing but recurs rapidly after repeated tappings, where the general condition of the patient is good and there is not marked wasting nor renal and cardiac complications.

The operation for this purpose, called epiplopexy (Talma, Morrison), is performed as follows : The abdomen is opened by a paramedial incision, the ascitic fluid allowed to escape, and the upper surface of the liver and the lower surface of the diaphragm well rubbed with gauze so that plastic inflammation and adherence of these surfaces results ; the peritoneum and posterior sheath of the rectus are stripped from the abdominal wall around the incision and the omentum secured with a few sutures in the space between these structures and the muscles ; finally the anterior sheath of the rectus is closed. New vessels form between the omentum and parietes and the liver and diaphragm, so that blood is diverted from the portal system along these. In suitable cases good results follow this operation, the patients being free from ascites for years and able to follow their normal avocations.

Another plan is to establish permanent drainage of the peritoneal cavity into the legs by silk threads passed through the femoral canal : good results are claimed in some instances, but the method does not go so near the root of the trouble as that first described, which should in most instances be given the preference unless the patient is unlikely to stand it, when the second plan may be safer.

AFFECTIONS OF THE OMENTUM

The great omentum may be looked upon as a movable portion of the peritoneum, and it plays a very important part in infective conditions. Being practically ubiquitous, it readily forms a protective layer around a focus of infection, becoming adherent and preventing general diffusion of the latter. Many a gangrenous appendix is rendered innocuous for a while by the kindly, encircling folds of the omentum. This power of forming adhesions has its drawbacks, as omental cords are formed in this manner which may lead to intestinal obstruction by snaring the intestine.

The ease with which the omentum adheres to the other viscera renders it very useful to the surgeon for filling in deficiencies of the latter. Thus

if after suture of a large perforation of the stomach the result appears weak, it may be covered with a piece of omentum sutured in position, making all snug. The omentum may be turned up as a flap, but it is better to use a loose portion cut away from its base, as turning up omentum we have noted is sometimes followed by torsion of the colon and obstruction of the bowel.

INJURIES. The omentum is easily torn in accidents or during operations, which may lead to fatal hæmorrhage if bleeding-points are not securely tied. When omentum is to be divided it should be transfixed and tied on each side of the line of division, as if divided and allowed to slip away the bleeding-point may take some time to find. If a hole be made in the omentum a

A   B   C
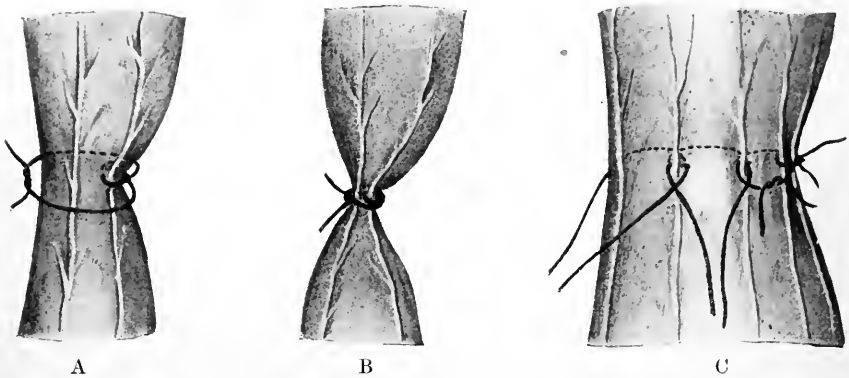
FIG. 43. Ligature of pedicles, *e.g.* of omentum. A and B, Stages of transfixing and tying with a single ligature. C, Tying off a broad pedicle with transfixing and interlocking ligatures.

loop of gut may protrude through this later and become strangulated ; hence any hole made or found at operation should be closed with sutures.

TORSION OR VOLVULUS OF THE GREAT OMENTUM. This occurs in middle-aged persons, and as a rule in association with an inguinal hernia, which is usually on the right side. The connection between the torsion of the omentum and the hernia is not quite clear unless the fact that the omentum can hang lower in the sac causes it to increase in length, and thus it becomes more elongated and with a narrower pedicle, a condition which predisposes to torsion, as is well known in the case of the sigmoid, which is the most common site of volvulus. In some instances the omentum may be actually in the hernial sac and irreducible, but this is not always the case.

Signs. There will be signs of local peritonitis, tenderness, and rigidity in the right iliac fossa and inguinal canal, with pain and sometimes vomiting, and a tender mass may be felt in this region.

The condition closely resembles that of appendicitis with abscess.

Treatment. The abdomen is opened and the mass removed after tying off the omentum.

ROLLED OMENTUM. Mention has been made already of the omenta tumour formed by its infiltration in tuberculosis and malignant disease of

the peritoneum. In either case the mass is elongate transversely, readily palpable, and separated from the liver by a band of resonance.

AFFECTIONS OF THE MESENTERY

INJURIES. Wounds with or without penetration of the abdominal wall may, if extensive, cause trouble from hæmorrhage. Any hole in the mesentery should be carefully sutured, as these are potent sources of intestinal obstruction. Where such a tear is large and several vessels are divided it will be necessary to resect a portion of intestine opposite the lesion, since the arterial anastomosis near the border of the gut is inefficient and gangrene of the intestine from deficient blood-supply is likely to occur.

THROMBOSIS OF MESENTERIC VESSELS. Both thrombosis and embolism of mesenteric vessels give rise to a form of intestinal obstruction which is more fully described under that heading. The condition presents as signs severe abdominal pain, shock, marked tympanitic distension and constipation, and sometimes the passage of blood from the rectum.

AFFECTIONS OF THE MESENTERIC GLANDS. Acute inflammation may result from any ulcerative condition of the intestine, e.g. enteric fever or appendicitis, and in the latter instance may proceed to suppuration, producing one form of appendix abscess.

Chronic inflammation of the mesenteric glands is due to tuberculosis and is very common in the young, especially in infants (tabes mesenterica), in whom the infection is widespread and often fatal, though in the more localized types recovery may result on general treatment for tuberculosis.

Tuberculous glands are often found near the cæcum, and the resulting mass, together with the mildness of the other signs, suggest a chronic appendicitis. When found at operation such glands, if caseating, are best removed, since if left to break down they may cause tuberculous peritonitis or intestinal obstruction from adhesions. Where a large mass of breaking-down tuberculous glands is found close to the intestine it will be best to remove the glands together with the portion of intestine involved, for if dissected out the blood-supply of the latter may be seriously damaged. We have found excision of the cæcum with the glands give excellent results in severe cases of this type.

MESENTERIC CYSTS. These are uncommon and their origin is much disputed. It is generally held that they are often of embryonic origin, being sequestrations from the alimentary canal or the ducts of the embryonic kidneys; they contain epithelial debris in their content. Several forms are described :

(a) Blood cysts, usually from bleeding into a pre-formed cyst.

(b) Dermoid cysts (ovarian, renal, or intestinal). When derived from the stomach or intestine they may have serous contents resembling ovarian cystomas.

(c) Chylous cysts result from extravasation of chyle into pre-existing cysts.

(*d*) Malignant cysts, from breaking down of malignant secondary deposits.

(*e*) Hydatids.

Signs. Unless discovered accidentally they cause no signs till of some size, when there is pain, constipation and vomiting, *i.e.* signs of chronic intestinal obstruction, while a swelling will be found in the lower abdomen, cystic and dull on percussion, unless crossed by resonant gut, and mobile in a circular direction, being tethered by the mesentery to the spine.

Treatment. Removal by laparotomy and dissection, with excision of intestine if necessary.

RETRO-PERITONEAL TUMOURS. These are fixed tumours coming forward from the back of the abdomen, and have to be distinguished from renal, pancreatic, and splenic tumours. Diagnosis is seldom possible without exploration. They are occasionally lipomas but more usually sarcomas, in which case they are seldom removable.

CHAPTER XX

SURGERY OF THE UPPER ABDOMEN

(Stomach, Duodenum, Liver, Biliary·Passages, Pancreas, and Spleen)

General Considerations and Examination : Injuries of the Stomach : Foreign Bodies in the Stomach : Inflammations of the Stomach : Gastric and Duodenal Ulcer : Acute Ulcer : Chronic Ulcer : Duodenal Ulcer : Jejunal Ulcers : Perforation of Peptic Ulcers : Hæmorrhage from Peptic Ulcers : Peptic Ulcers resisting Medical Treatment : Stenosis of the Stomach from Ulcers : Hourglass Stomach, Pyloric Stenosis : Perigastritis : Duodenal Ulcer : Acute Dilatation of the Stomach : Chronic Dilatation of the Stomach : Congenital Stenosis of the Pylorus : Cancer of the Stomach : Pylorectomy for Cancer : Total Gastrectomy : Operations on the Stomach, Lavage, Gastrotomy, Gastrostomy, Pyloroplasty, Gastro-jejunostomy : Complications of Gastro-jejunostomy : Jejunostomy : Injuries of the Liver : Liver Abscess : Hydatids of the Liver : Anatomy of the Biliary Passages : Injuries of the Biliary Passages : Gall-Stones : Results of Gall-stones : Cholecystitis : Cholangitis : Tumours of the Gall-bladder : Tumours of the Bile-Ducts : Operations on the Biliary Passages, Cholecystostomy, Choledochostomy, Cholecystectomy, Choledochotomy, Cholecystenterostomy : Injuries of the Pancreas : Acute Pancreatitis : Subacute Pancreatitis : Pancreatic Abscess : Chronic Pancreatitis : Pancreatic Calculi : Pancreatic Cysts : New Growths of the Pancreas : Injuries of the Spleen : Floating Spleen : Splenic Anæmia : Splenectomy.

GENERAL CONSIDERATIONS AND METHODS OF EXAMINATION. Patients suffering from diseases of the above group of organs in many instances first come under notice for the symptom *dyspepsia*, and it should be fully realized that this disorder may be due to disease of many organs besides the stomach, whether in the upper abdomen, *e.g.* liver or pancreas, the lower abdomen (appendix), or associated with heart, lung, or kidney disease. By dyspepsia is meant pain or discomfort of varying degree having some relation to ingestion of food. This may arise while food is being taken, shortly after, or so long after as to be chiefly noted immediately before the next meal, when it is aptly described as " hunger pain." Pain of this sort coming on at night and relieved by taking food is very characteristic of duodenal ulcer. The discomfort varies in degree ; thus desire for food is a normal condition at regular intervals, and distaste for food is a form of dyspepsia and called anorexia, which is very common in febrile conditions, and when referring to meat especially and of some duration is suggestive of cancer of the stomach. In other instances there is much flatulent distension or feeling as if the abdomen were over-full, relieved by passing flatus by mouth or rectum ; this is very common in gall-stone dyspepsia. In other instances the pain is very severe, and then may be fairly called colic, being paroxysmal, rising in severity to a certain point and then gradually subsiding ; very

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often such pain really is a colic from spasmodic contraction of the pylorus or gall-bladder, and sometimes perhaps of the appendix.

Vomiting is another symptom of frequent occurrence, and its relation to food should be noted as well as its effect on the pain. Thus vomiting at irregular intervals, not related to meals, is probably not due to abdominal disease and is possibly renal or cerebral (*e.g.* the cerebral vomiting noted in cases of tumour of the brain). Vomiting often relieves the pain in gastric ulcer, but seldom when the affection is cancer of the stomach, while in dyspepsia due to gall-stones there is often rather retching than real vomiting, with but little relief. Another form of vomiting of nervous origin is that associated with severe pain, found in gastric crises and due to tabes dorsalis ; the possibility of mistaking this condition for gastric ulcer, &c., renders an examination for this disease and its exclusion essential before operating on any dyspeptic patient.

The character of the vomited material is often suggestive. Thus large vomits up to a gallon or more at infrequent intervals of two to three days, the material being brown, bubbling and fermented, is characteristic of a dilated stomach, from whatever cause. Slightly altered food will be found in vomiting due to gastric ulcer, while large quantities of clotted blood (hæmatemesis) are found where bleeding from an ulcer is taking place. Altered blood in the vomit having the appearance of " coffee-grounds " is frequent in cancer of the stomach.

Intermittence of these dyspeptic symptoms is more usual in duodenal than in gastric disease.

The well-known condition *jaundice*, or presence of bile in the circulation and tissues generally, is common in certain affections of the biliary passages and pancreas.

Examination of the fæces may throw some light on these conditions. *Melæna* is commonly found in cases of gastric and duodenal ulcer, and consists of the passage in the motions of blood which has been altered by the process of digestion and forming a tarry, iridescent mass ; this is to be distinguished from blood escaping from the lower part of the intestine (colon or rectum), when the blood will be unaltered and dark red, either liquid or clotted, quite different from the former material.

Absence of bile from the stools is easily recognized from the pallor and fatty appearance of the motions, and is due to some condition of biliary obstruction.

Physical examination of the abdomen may reveal many conditions. A dilated stomach may be quite visible on the surface, recognized by the shape of the distended organ, while at times waves of peristalsis will be noted. Such distension is made more clear by distending the organ, by administering a dram of carbonate of soda, followed by one of tartaric acid ; the ebullition of carbonic acid gas rapidly distends the stomach (this is uncomfortable and not often needed).

A distended gall-bladder may form a visible prominence below the ninth costal cartilage.

Palpation will reveal swellings of the stomach, liver, bile-passages, pancreas and spleen, and percussion will show the relation of these to the gas-containing organs, lung, stomach, and intestine. While palpating the abdomen, if the patient be shaken, a " succussion plash " will be elicited in cases of dilated stomach.

Special Methods of Investigation. The stomach should be gauged as to its powers of secretion by the " test meal."

The patient swallows a couple of pieces of dry toast and a cup of tea ; an hour later the stomach-tube is passed and the patient placed on one side and asked to strain. The relics of the small meal are thus syphoned off and tested for its total acidity and the amount of free hydrochloric acid present. According to Panton and Tidy the findings for the acidity of normal stomachs are : total acidity, 40 to 50 per cent. ; free hydrochloric acid, ·08 to ·12 per cent. Absence of free hydrochloric acid and a low total acidity in cases of not more than a year's duration suggest cancer of the stomach, but a similar finding where the dyspeptic condition has been present for years suggests some form of atonic gastritis, being often found with gastroptosis and not uncommon in patients suffering from gall-stones.

Increase of the free hydrochloric acid and a high total acidity suggest gastric or duodenal ulcer, but where cancer has followed on a previous ulcer the acidity will in most instances be high. According to the above authorities the average in gastric ulcer is : total acidity 58 per cent., free hydrochloric acid ·13 per cent. ; in case of duodenal ulcer much higher readings are common, the total acidity reaching 70 per cent. and over, while the amount of free hydrochloric acid may reach ·3 per cent. Too much reliance must, however, not be placed on any one method of examination ; for instance, in the case of the largest duodenal ulcer we have yet seen at operation, there was no free hydrochloric acid and the total acidity was low.

The stomach-tube is also of service in making the diagnosis of an hour-glass stomach (*see later*) and in estimating the motile power of the organ. If the stomach be washed out clean and a small meal given and then after five hours the organ be washed out again, it should be empty, and the presence of undigested food points to serious affection of the organ.

A good deal may be learned about the functions of the stomach by examination with the fluorescent screen after a meal of porridge or mashed potatoes containing bismuth carbonate, the latter opaque material being readily seen. The position and movement of the shadow thrown by the bismuth will afford evidence on the size of the stomach and its motile power, the condition of the pylorus, and whether the hour-glass condition is present, &c. (Fig. 45, p. 145.)

Finally, the organ may be inspected with various gastroscopes. Those introduced through the mouth present too many difficulties to be of great service up to date. The most practical method at present would appear to be direct gastroscopy and diaphanoscopy (Rovsing), for which a laparotomy is needed. This surgeon employs a large cystoscope, which has also an

air-tube to inflate the stomach. The organ, exposed by laparotomy, is opened by a small incision and the gastroscope secured inside, and is first examined from outside in a darkened room by transillumination with the lamp inside (diaphanoscopy); this will show shadows where ulcers are present, and having located the disease roughly in this manner, the observer examines by direct vision through the gastroscope; this should be of assistance in locating small ulcers. In most instances laparotomy followed by inspection and palpation of the organ is needed to make an exact diagnosis, and it is important to recognize the value of early laparotomy where there is any possibility of cancer of the stomach, which is a common disease in the middle-aged.

AFFECTIONS OF THE STOMACH, PYLORUS, AND DUODENUM

Injuries to and Foreign Bodies inside the Stomach. The stomach may be injured (1) from without by crushing or penetrating wounds, (2) from the interior by ingested materials.

(1) *Wounds and Rupture of the Stomach.* Where the stomach-wall is penetrated there will follow extravasation of its contents and peritonitis as in lesions of other hollow, abdominal viscera. In penetrating wounds of this part of the abdomen the stomach should be examined, and it should be recognized that wounds of the stomach may complicate those of the lower thorax. Where the perforation is the result of injury without penetration of the abdominal wall, *e.g.* from crushes, there will be found the signs already described under abdominal injuries, viz. shock, rising pulse-rate, rigidity and tenderness of the upper abdomen, possibly loss of liver dullness due to escape of gas, while vomiting of blood will suggest the nature of the injury. If the extravasation be small it may be walled off by adhesions and a subphrenic abscess result, but if large a diffuse peritonitis will swiftly follow.

Treatment. Immediate laparotomy is the only hope in most instances (*see,* however, Gunshot Injuries of Abdominal Viscera). A long paramedial incision above the umbilicus should be made (note that diagnosis is often uncertain, and in such cases the surgeon will often find rupture of the liver, spleen, or intestine alone or in addition, and must be prepared to deal with each and all). The rent or perforation is, if possible, occluded with intestinal clamps, the extravasated matter sponged away, and the breach repaired with two rows of sutures, a deep layer of chromic catgut through all coats and a superficial row of silk taking up only the peritoneum and burying the former sutures.

Continuous suturing should be employed if possible, but where there is difficulty it may be safer to employ interrupted sutures as there is less chance of these becoming loose. The neighbourhood of the wound is cleaned with saline and the organ examined for further injuries, especially when the lesion is a penetrating wound, when the posterior surface should be examined, carefully opening the lesser sac of peritoneum through the meso-colon if there be any doubt about the matter.

A rapid but careful examination should be made of the liver, spleen, and upper part of the jejunum, and if further lesions found the abdomen closed. Where there is little extravasation the abdomen is closed without drainage if the peritoneum appears clean, but if this is uncertain it will be better to make a small paramedial incision above the pubis, swab out any fluid that may have gravitated there, and drain the pelvic pouch for twenty-four hours or longer if much fluid escapes.

(2) *Injury to the Stomach from Objects swallowed and Foreign Bodies in the Stomach.* The stomach is seldom injured at once by solid materials which are swallowed, even when sharp and ragged, and it is surprising what bulky, irregular objects may pass the pylorus and escape per rectum or lodge at the internal sphincter. Should the object swallowed be smooth it should be left for a while and its progress studied with X-rays, if opaque to these. If the body be seen to remain in the stomach for several days, or if a transparent body is not passed per rectum after two or three weeks, it will be safer to remove by laparotomy. Should the object swallowed be sharp or ragged, such as an open knife, a fork, a tooth-plate with hooks or broken glass, or if symptoms suggesting a perforative lesion of the stomach follow ingestion of a foreign body, the abdomen should be opened at once and the object removed.

A curious type of foreign body is the *hair-ball*, which is found in the stomach of young women who are in the habit of devouring their hair (a nervous habit akin to biting the nails). The swallowed hair has a pre-dilection for remaining in the stomach, where it curls up and becomes felted by the churning of the stomach into a mass which in time may attain the size of a cocoanut. The signs of this condition are dyspepsia, occa-sional vomiting, associated with the above-mentioned form of cannibalism, while sometimes the ball can be felt as a doughy swelling in the epigastrium, varying in position with the amount of distension of the stomach. These balls should be removed by gastrotomy.

Gastrotomy. Operation for removing foreign bodies from the stomach or exploring the interior of the organ.

The stomach is exposed by a paramedial incision to the left of the mid-line in the epigastrium. The stomach is drawn into the wound and palpated till the foreign body is felt. The latter is then manœuvred into an accessible situation and the stomach over it incised vertically, *i.e.* parallel to the direction of the vessels in its wall, the foreign body removed, and the organ closed again with two layers of continuous sutures, after which the abdominal wound is closed without drainage.

Corrosive Fluids in the Stomach. Such substances as strong acids or alkalies when taken into the stomach produce rapid necrosis of the wall and, if penetrating deeply, perforation into the peritoneal cavity : in such a condition, owing to the widespread mischief, operation is out of the question, as it would involve removal of most of the stomach. The treat-ment, with neutralizing antidotes and demulcents, &c., suitable at this stage, is described in works on medicine. Later, when the patient survives,

the resulting ulcers, which in the stomach itself are most marked at the pylorus, tend to cicatrize like other ulcers and produce stenosis of the affected parts (the œsophagus also is commonly affected), causing pyloric stenosis. Hence, if signs of dilated stomach occur within a few weeks of swallowing a corrosive poison (such signs as vomiting of increasingly large quantities, a succussion plash of the organ, and emaciation), the stomach should be explored and probably gastro-jejunostomy performed. This will relieve the condition completely as far as the stomach is concerned, though the œsophagus may also require treatment.

INFLAMMATIONS OF THE STOMACH. These may be acute or chronic and are often amenable to medical measures, but there are certain forms, some of which are very common, for which surgical interference is most beneficial and in some cases urgently needed as a life-saving measure. It is especially the severe suppurative or ulcerative forms of inflammation which come under the surgeon's notice, the less aggravated or catarrhal conditions often yielding to medical treatment and only coming to the surgeon when such measures fail. The more severe inflammatory affections may be divided into the diffuse or phlegmonous and the localized or ulcerative.

Acute Phlegmonous Gastritis, Diffuse Cellulitis, or Abscess of the Stomach Wall. This affection, which is not common, may originate in an otherwise healthy person or as a sequel to some general infection, *e.g.* puerperal fever, or in a case of cancer of the stomach.

Anatomy. There is intense œdema and congestion of the wall of the stomach with diffuse, purulent infiltration ; in other examples the suppuration is more circumscribed and forms an abscess.

Signs. The onset is sudden, often with a rigor and high fever ; there is severe pain in the upper abdomen, which becomes rigid and tender ; later a tender mass may be noted on palpation of the epigastrium ; delirium and coma, ending in death, are frequent ; the abscess may burst into the interior of the stomach and be vomited.

The diagnosis from other acute conditions of the upper abdomen, such as pancreatitis and acute cholecystitis, is often impossible.

Treatment. Laparotomy and drainage of the abscess, if present ; in the more diffuse types the prognosis is almost hopeless.

GASTRIC AND DUODENAL ULCERS (peptic ulcer). Less violent and more localized inflammation of the stomach and duodenum gives rise to ulcers which, with their complications, form a fertile field for surgical measures. These conditions are due, in part at any rate, to the presence of the acid gastric juice, being often associated with hyperacidity of the latter, and are found at any point in the stomach-wall and in the upper part of the duodenum above the entrance of the bile-duct, whence the name peptic ulcer.

GASTRIC ULCER. This is a fairly common disease, bearing in its train a very considerable mortality and many unpleasant sequelæ, which, together with the original ulcer, can generally be cured by operative measures.

Etiology. The sex incidence is uncertain, statistics from various sources differing widely. Predisposing causes are anæmia, cardiac disease and arterio-sclerosis, but above all oral-sepsis. The affection is, no doubt, in a very large measure due to infection of the stomach from the mouth, assisted by irregular meals and irrational food, *i.e.* general maltreatment of the stomach. From the differences in their duration gastric ulcers may be divided into acute and chronic varieties, though naturally intermediate forms occur which are not easily referred to either group.

(1) *Acute Gastric Ulcers.* These are found principally in females of twenty to thirty years of age, anæmic servant girls being often affected.

Anatomy. These ulcers, which are often multiple, are found at any part of the stomach, but mostly near the pylorus and towards the lesser curvature. Acute ulcers differ much in appearance during life and after death. In the living they may be mere slits in the mucosa with some œdema of the mucosa around, hardly visible but oozing blood ; these are known as *erosions*, and may be seen in a stomach opened by operation for hæmatemesis. In other instances the ulcers are small ragged holes varying in size from a pea to a shilling, with great œdema and thickening of all the coats of the stomach-wall around : such are the ulcers found where perforation has just occurred. After death, the congestion and œdema being absent or greatly diminished, the ulcers appear as punched-out depressions shelving to the lowest point of their floor, where they may perforate into the peritoneal cavity. Acute ulcers heal without much scarring or contraction, and though sometimes bleeding freely, are seldom fatal from this cause ; their great danger is perforation and subsequent peritonitis.

(2) *Chronic Gastric Ulcers.* These are found in older persons, usually over thirty, and quite as often in men as in women. They are found mostly in the pyloric part of the stomach, often on the posterior surface, but may cross the lesser curvature and occupy part of the anterior wall as well (saddle-ulcers). The ulcers fairly often involve the pylorus and have little tendency to heal, but remain as chronic indurated, callous ulcers. Chronic ulcers are often much larger than the acute form, and may be several square inches in area ; the edges are indurated and thick, while there is much fibrosis in their bases and around, which is quite obvious even after death. Chronic ulcers often become adherent to surrounding organs, especially the pancreas. Owing to their chronicity and the amount of fibrosis which accompanies their formation, they produce great distortion of the organ and are a common source of *pyloric stenosis* and *hour-glass stomach.* The risks of perforation is less with these than with acute ulcers on account of the adhesions around ; still this complication is by no means uncommon. Hæmorrhage from the ulcer is fairly common and more serious than in the acute variety, as there is far more chance that a really large vessel, *e.g.* the coronary, is eroded, so that death from hæmorrhage in this form of ulceration is not uncommon.

DUODENAL ULCERS. These are found usually in the first part of the duodenum, and always above the biliary papilla. This form of ulcer is found commonly in men over thirty associated with hyperacidity and oral

sepsis. They have been fairly often noted as complications of burns and other septic conditions, *e.g.* abscess of the breast. It is often by no means easy to decide whether the ulcers in this region are above or below the pyloric ring. Mayo gives the pyloric vein as the line of demarcation between the stomach and duodenum. Ulcers in this position must generally be regarded as acute, for they heal with but little scarring, and in spite of the frequency of the condition in surgical practice, it is rare to find post-mortem distortion of the duodenum from scarring, as is the case with healed chronic gastric ulcers ; moreover, the duodenal ulcer perforates very frequently. On the other hand, these ulcers are often very much indurated and with adhesions round, and occur in subjects in whom chronic gastric ulcers are most frequent, viz. middle-aged men. These differences may be perhaps explained by assuming these ulcers to be a series of recurring acute ulcers rather than one chronic ulcer, and the remission of symptoms is in favour of this view. Duodenal ulcer endangers life very frequently from perforation, less often from hæmorrhage, but the severe dyspepsia and dilatation of the stomach from this disease, render operative treatment often necessary.

PEPTIC ULCERS OF THE JEJUNUM. These are in most instances one of the unfortunate sequelæ of the operation of gastro-enterostomy, and both clinically and anatomically resemble acute ulcers of the stomach, sometimes endangering life by perforation. This variety is described more fully under the complications of Gastro-enterostomy. Apart from gastro-enterostomy perforating ulcers do occasionally occur in the upper jejunum, presenting the same signs as those found in the similar complication of gastric ulcer and demanding immediate operative measures.

Signs. (*a*) In a good many instances ulcers, especially the acute variety, remain latent, presenting no symptoms till perforation or grave hæmatemesis takes place.

(*b*) Pain coming on after meals at a time varying from half an hour to two hours is common and may be very severe. In cases of ulcer of the duodenum pain is likely to commence two hours or more after meals, and may be worst when the stomach is empty (hunger-pain), and then is often noted at night. The pain may be in the epigastrium or in the dorsal region at the tenth to twelfth spines.

(*c*) Vomiting, which is fairly common in cases of gastric ulcer and rare in those of the duodenum, is likely to occur one to two hours after meals, is acid, and relieves the pain.

(*d*) Hæmatemesis, or vomiting of unaltered dark red liquid or clotted blood, is not uncommon, and may occur in large amounts and be dangerous, leading to severe anæmia.

(*e*) Tenderness in the epigastrium is often noted on either side.

(*f*) Anæmia and wasting are common in the more severe examples.

(*g*) The test meal will show excess of free hydrochloric acid and of the total acidity in many cases.

In cases of duodenal ulcer vomiting will only result where there is stenosis of the latter from a hypertrophic ulcer, while the gnawing pain coming on

many hours after food, with acid eructations, often in the night, and so severe as to simulate biliary colic but relieved by eating biscuits, is very characteristic.

Treatment. Rest in bed, careful feeding with meat-juice, peptonized milk in small quantities, lavage of the stomach if irritable, keeping the bowels freely opened, and above all, clearing the mouth of all sources of infection in the shape of pyorrhœa, carious stumps, &c., are the main points in treatment on medical lines, and the reader is referred to works on this subject for further points as to diagnosis and treatment.

Indications for Surgical Treatment in Gastric and Duodenal Ulcer. Urgent indications are :

(1) Perforations into the peritoneal cavity.

(2) Hæmatemesis from chronic gastric or duodenal ulcers.

Indications where operation is advisable but not immediately urgent are :

(3) Cases which resist complete medical measures, thoroughly carried out for two months. This will include most chronic ulcers, for it may be doubted if many of these will heal on medical measures alone.

(4) Where contraction following ulceration causes stenosis of the stomach and interference with the passage of gastric contents, *e.g.* pyloric stenosis and hour-glass stomach.

(5) Where adhesions about the stomach are interfering with the stomach.

(1) *Perforation of Gastric and Duodenal Ulcer. Signs.* The onset is sudden and may occur in patients who have no previous gastric history (latent ulcer) or where a few days or weeks dyspepsia has been noted (acute ulcer) or where there is a long history of dyspepsia, hæmatemesis, &c. (chronic ulcer).

The patient complains of very severe pain which does not intermit as does that of colic, and is most marked at first in the epigastrium. Vomiting at the commencement may be found in about half the cases but is not a marked symptom, and is unusual in cases of perforation of the duodenum. On examination the abdomen is extraordinarily rigid, very tender, and in the early stages retracted and scaphoid. The respiration is shallow and restrained, the patient groaning with each expiration.

The liver-dullness is often diminished or abolished, and this sign is of value when the abdomen is still retracted as a sign of escape of gas into the peritoneum from perforation of a hollow viscus. Later, when the abdomen is distended and tympanitic, loss of liver-dullness is of little significance, being often due to distension of the intestines and not to free gas in the peritoneum. The amount of shock is variable, for although the patient is often pale and livid with drawn face, yet the pulse frequently remains slow, strong, and full for several hours, but (and this is important) its rapidity gradually increases if noted every quarter of an hour in doubtful cases. In other instances the shock is marked from the first, the pulse being small and feeble. In all cases the pulse by degrees becomes rapid and small, assuming the characters of the " thready " pulse of peritonitis

as the latter condition becomes more fully developed. The temperature is usually subnormal at the onset but may rise after some hours.

Perforation usually occurs on the anterior wall and in the neighbourhood of the pylorus, it being often difficult to decide whether the ulcer is gastric or duodenal. The onset is more severe if the perforation be large and the stomach full so that a large amount of its contents are discharged rapidly into the peritoneal cavity. There is also a considerable variation in the toxicity of the contents of different stomachs, since one finds that some cases where there is massive effusion and operation is delayed do as well or better than cases operated on early and in which there is a small effusion. On the whole, the amount of the effusion and the time that elapses before operation is performed very seriously alters the prognosis for the worse. In cases where the perforation is small and little of the gastric contents escapes it may be walled round by adhesions and lead to the formation of a subphrenic abscess.

Diagnosis. The sudden onset and great rigidity and tenderness of the abdomen, especially noted in the epigastrium, are not likely to be mistaken for anything else. Acute phlegmonous inflammation of the stomach or gall-bladder and acute pancreatitis present somewhat similar signs but with less sudden onset and more often with fever, though this is often absent in the latter condition. More important is it to note that appendicitis of the chronic variety often presents symptoms of dyspepsia, and should this condition suddenly become acute and give rise to spreading peritonitis, may readily suggest the perforation of a gastric ulcer ; while, on the other hand, after perforation of a duodenal or pyloric ulcer the extravasated fluid often tracks down to the right iliac fossa along the outer side of the ascending colon, and may present signs closely resembling those of appendicitis. These difficulties give a hint as to the technique to be observed in operating for supposed cases of this affection.

Treatment. Early operative measures are the patient's only hope in most instances. If let alone in a few instances the perforation will be walled off with lymph and so healed, but this can only occur where the perforation is very small and the extravasation minimal. In another few cases the effusion may become walled off by adhesions and a subphrenic abscess result, but the mortality of this condition, even should it occur, is far too high to allow of expectant measures being countenanced for an instant. The results of early operation for perforations of gastric and duodenal ulcers are excellent. Our results show 60 per cent. recoveries for all cases.

Operation. Even when very confident of the diagnosis, it is safest to make a small incision either through the right rectus sheath below the umbilicus or a muscle-splitting opening in the right iliac fossa. This does not take long, and the appendix can be examined and removed if diseased, while the nature of the exudate and the presence of free gas will be noted and a diagnosis of perforation of the stomach or duodenum readily made. This plan will save the surgeon the mortification and the patient the danger of vainly searching for a perforation which is not present, among lymph

around the stomach (which may be considerable in amount where diffuse peritonitis is present) in a case where there is really a leaking appendix-abscess. Having excluded the appendix by this preliminary incision (which later serves for drainage) and decided that the lesion is in the upper abdomen, the surgeon opens the latter by a paramedial incision through the right rectus above the umbilicus, which should be of good length (four to five inches) to allow of good access and rapidity of working. The ulcer is found by pulling out the pylorus and examining for perforation and feeling the latter, or by tracing the coagulated lymph to the point where it lies thickest. There is nearly always much œdema and induration of the wall of the viscus around the perforation, rendering recognition easy. When the ulcer is not found on the anterior wall or at the pylorus the posterior wall must be examined, opening the lesser sac of the peritoneum through the mesocolon. The small round, punched-out aperture of the perforation, varying in size from one-eighth to half an inch in diameter, is soon recognized, and the discharge of food material makes this more certain. The orifice of the perforation should be occluded with two or three sutures of chromic catgut passed wide of

Fig. 44. Suturing a perforated ulcer, showing the deep suture taking the whole thickness to occlude the perforation of the superficial invaginating stitch taking up the peritoneal and muscular roots.

the perforation and through all the coats of the stomach (if not obtaining a good grip these will soon cut their way out). Having blocked the perforation in this way, it should be infolded if possible with a second layer of silk sutures passed interruptedly and taking up peritoneum and muscle, till the ulcer and the deeper sutures are buried. These sutures must be passed through normal stomach-wall outside the œdematous area surrounding the perforation, or they will not hold. Having closed the perforation, the next step is to remove excess of exudate with sponges, which are pushed into the flank and pelvis till most of the fluid is soaked up and removed.

The next question which arises is whether a gastro-jejunostomy should be done. It is essential in practically all cases where the perforation is near the pylorus or in the duodenum, as the infolding of the ulcer will cause much stenosis and possible obstruction at that point. In all cases of large chronic ulcer gastro-jejunostomy is advisable if the patient is likely to stand the extra quarter of an hour's operating, which is probably the case where there is any prospect of the patient's recovering from simple suture of the ulcer. In cases of small, acute ulcer of the body of the stomach, such as is found in young women, gastro-enterostomy is not needed as the ulcers

heal without, and if the ulcer be thoroughly invaginated in such cases feeding may be commenced early. Thus in most instances gastro-enter-ostomy will be indicated, since the presence of the stoma renders healing of the ulcer more rapid by diminishing the acidity of the gastric juice, while the fact that the food can readily pass into the intestine makes nutrition an easier matter, for there can be little doubt that the persistence of gastric ulcers is in some measure due to the malnutrition caused by the dyspepsia and consequent abstention from nourishing food.

Excision of perforated ulcers is not advisable, as it is unnecessary in the small variety, and removal of the large chronic ulcer is a big operation and quite inadvisable in patients already much reduced by the shock of perforation and early peritonitis.

Difficulties.   Where the ulcer is large and the induration around very extensive it may be impossible to infold it.   In these cases, having occluded the perforation, the ulcer may be covered with an " omental graft " or a gauze tampon passed down to the perforation for drainage in case it gives way and to form adhesions, a gastro-enterostomy being performed if possible. As an alternative to this measure, which may be difficult, a jejunostomy is done by Kader's method (*see* Gastrostomy) ; by this means the patient can be fed into the jejunum at once and the stamina well maintained.   We have found this method serviceable in severe cases.   In fact, where the patient is very much reduced by a perforation which has been present many hours, probably the best plan will be to occlude the ulcer with one or two sutures, pack gauze down to the aperture and perform jejunostomy, feeding thus for three or four weeks.

Drainage.   Where the effusion is slight the abdomen may be closed tight after removing exudate by judicious and careful sponging.   Where it is a large amount, after removing the bulk, as mentioned, by sponges, a large tube should be passed down into the recto-vesical pouch through the original incision in the lower abdomen and the patient placed in the Fowler position, the tube being left *in situ* for one to four days, according as it acts success-fully as a drain.   In most cases it is advisable to place a drain in this position for some hours.   Before closing the abdomen the whole stomach, including the lesser sac, must be examined, since multiple perforations are some-times found.

After-treatment is on the lines described for peritonitis.   It is very important to cause absorption of fluid into the tissues by saline infusions, and as soon as vomiting ceases by feeding.   The bowels are opened early with calomel and flatulence relieved with strychnine and turpentine enemata.

(2) *Hæmorrhage from Gastric or Duodenal Ulcers.*   Bleeding is the cause of death in a considerable number of cases of chronic gastric ulcer, but this termination is quite rare in acute cases.   For this reason, even where hæmorrhage is severe in young subjects, especially girls, with but short history of dyspepsia, &c., operation is very rarely advisable, as the condition subsides under medical treatment.

Where the ulcer is chronic, as evidenced by the long history and its

occurrence in middle-aged persons, often males, operation should be under-
taken for one attack of severe bleeding or repeated slight attacks.   Bleeding
must be regarded as a danger-signal in cases of chronic ulcer, indicating
that medical measures alone are unlikely to cure the affection ; in these
cases the ulcer often erodes a large vessel such as the splenic or coronary
arteries, and it is unwise to wait for a second attack of hæmorrhage lest
the resistance of the patient be so reduced that he succumbs to the added
shock of operation.

The general rule, then, is not to operate for hæmatemesis in young
women unless there is good evidence that the ulcer is chronic, but in hæma-
temesis occurring in patients over thirty to operate after the first large
hæmorrhage, simply giving the patient a few hours to recover the initial
collapse from the bleeding.   Should, however, the bleeding be progressive,
operation should be undertaken while it is still going on, as in all probability
a large vessel is eroded, so that operation and securing the bleeding-point
is the only hope of recovery, and although the outlook is not good, still
the longer operation on such cases is delayed, the worse the prognosis becomes.

Operation.   Taking all precautions to reduce shock, the abdomen is
opened through either upper rectus and the stomach examined ; the ulcer
will often be found as a thickened, puckered mass on palpating the outside
of the organ either in front or behind (after opening the lesser sac).   Where
the ulcer is small it should be excised and the resulting opening occluded
with two rows of sutures.   If the ulcer is large and adherent to surrounding
structures, especially on the posterior surface, excision may be too difficult
and prolonged to be safe in such debilitated subjects.   In such cases, if
the ulcer be on the anterior wall it should be infolded with sutures, taking
up all coats down the submucosa, which will thus effectually strangle the
vessels leading to the ulcer and prevent further bleeding ; ulcers on the
posterior wall should be exposed by incision through the anterior wall of
the stomach, tying or under-sewing the eroded vessel at both ends.   In
all the above cases a gastro-enterostomy should be performed, posterior
if possible, but where the posterior surface is adherent the anterior retro-   .
colic method should be adopted.

When no sign of ulcer can be detected by palpation outside the stomach
it is of little use to open the organ and search for bleeding-points, for in
such cases there are likely to be several small bleeding ulcers of the " erosion "
variety, difficult to find and wasting valuable time.   Such cases are some-
times described as " gastrostaxis," but usually post-mortem small ulcers
can be found.   In this class of case it is best to perform a posterior gastro-
enterostomy to give the stomach rest, prevent its distension by blood-clot,
and reduce the acidity of the gastric juice ; the results of this plan in
whatever way it works are satisfactory.

(3) *Cases of Gastric Ulcer resisting Medical Treatment.*   After a patient
suffering from gastric ulcer has been under efficient medical treatment for
two to three months and the ulcer is still active, as evidenced by dyspepsia,
pain, local tenderness, vomiting, and high acidity of the gastric contents,

surgical treatment is advisable, as there can be little doubt that such ulcers are chronic and unlikely to heal on medical measures alone. The methods available are excision of the ulcer and gastro-enterostomy, separately or combined.

Excision of the ulcer is only suitable where it is small and when the effect of excision does not narrow the stomach, *i.e.* for ulcers of the body. Where occurring in the region of the pylorus, as some stenosis will surely result after excision, gastro-enterostomy should be performed as well.

Excision is advisable because there is some risk of the ulcer becoming cancerous as time goes on, though probably this risk is not so great as the statistics of American surgeons would tend to prove.

The general trend of opinion at present is rather in favour of performing gastro-enterostomy in all cases, whether the ulcer is excised or not, as excision, though satisfactory in some instances, yet does not remove the underlying causes of hyperacidity, &c., and there may be recurrence of ulcers, while the complete alteration of the gastric drainage by the anastomosis renders recurrence less likely.

Gastro-enterostomy must be done alone where excision is impossible. In all cases the portion removed should be submitted to microscopical examination, and if the condition has become cancerous a more complete removal of the stomach should be performed as soon as possible.

(4) *Stenosis of the Stomach resulting from Ulceration.* Stenosis of the stomach resulting from past ulceration may occur at any part of its length, being most usual at the pylorus. When stenosis occurs at some other point along the body of the organ the result is a division of the organ into two or more pouches ; such a condition is described as an " hour-glass stomach " from its fancied resemblance to that form of chronometer. The narrowing may result from contraction of fibrous tissue in the wall of the organ itself : a comparatively small ulcer may in this way block the pylorus, but to produce stenosis of the body of the organ sufficient to cause symptoms a large ulcer is needed. Such ulcers are found at the lesser curvature extending for a considerable distance along the anterior and posterior surfaces (" saddle ulcers ").

Adhesions around the stomach by their contraction may also cause stenosis, and may be consequent on gastric ulcer or disease of other organs such as the gall-bladder. Malignant disease will often produce stenosis of the stomach, usually affecting the pylorus, less often resulting in the formation of an hour-glass stomach.

Signs. In both forms of stenosis the main results are similar, viz. dilatation of the stomach (gastrectasis) above the stenosis with hypertrophy of its wall. The earlier signs are similar, viz. dyspepsia and retention of food in the stomach over-long (as found by test meals). The latter result is very characteristic from the intermittent vomiting of large quantities of brown, frothy, fermented liquid at intervals of one to three days, the amount varying from a few pints to many quarts.

On inspection the distended stomach may be seen clearly outlined and reaching to the umbilicus or lower, while peristalsis of its wall may be visible and increased by deep palpation. The size of the organ can be roughly estimated by percussion, and by screening after ingestion of a bismuth meal its size more clearly defined, bearing in mind that the normal organ in the erect position when filled with a meal may reach an inch below

Fig. 45. Hour-glass stomach due to the contraction of a gastric ulcer (radiogram after a bismuth meal). Note the horizontal level of the bismuth in the proximal pouch, the narrow contracted isthmus, the bulk of the bismuth in the distal pouch.

(*Kindly lent by Dr. Gilbert Scott.*)

the umbilicus : further information may be obtained by washing out the stomach.

The diagnosis between pyloric stenosis and hour-glass stomach is not always an easy matter, and the following points may be of assistance :

On inspection of the abdomen with the stomach distended by its contents or inflated specially with gas, it may be possible to note a division of the dilated organ into two portions in cases where there is a condition of hour-glass stomach, whereas in cases of pyloric stenosis the shape of the swelling is that of a single huge stomach. If emptied with the stomach-tube a stomach simply dilated from pyloric stenosis can be washed clean, and if a tube be inserted an hour later no more fermented liquid will be obtained ;

but if the condition be one of hour-glass stomach, owing to regurgitation of material back from the second into the first pouch, which alone is cleaned by lavage, there will be found some fermented material on the second introduction of the tube. If a measured quantity of fluid be poured down the tube less can be drawn out in case of hour-glass stomach, as some will pass into the second pouch. Also the succussion plash (clappotage) will be found after the first pouch is emptied by the tube, though in cases of pyloric stenosis washing out the organ removes this sign. This plash or gurgling is heard in cases of dilated stomach containing a considerable quantity of gas and fluid by shaking the patient, and may be noted with the unaided ear, or more easily with the stethoscope : it may be heard in the normal stomach within two hours of a full meal ; after four hours it is pathological. The same sound is also heard when a hydro-pneumo-thorax is present. Finally, screening the patient after ingestion of bismuth will show the food-mass passing from one pouch into the other and finally through the pylorus (Fig. 45).

Of general signs, wasting is marked in the more prolonged examples, and " tetany " or tonic carpo-pedal spasm is sometimes found to accompany dilatation of the stomach (see later). The diagnosis between pyloric stenosis and hour-glass stomach is important, for if the proximal pouch of an hour-glass stomach be small the dilated second pouch may be regarded as the whole stomach and the condition taken for a case of pyloric stenosis, and drainage of the second pouch alone is useless and often fatal.

Diagnosis. Dilatation of the stomach due to simple fibrous stenosis must be distinguished from that due to atony of the stomach without stenosis and from malignant disease of the stomach, and will be further detailed under dilatation of the stomach.

Treatment. Where the condition is one of pyloric stenosis a posterior gastro-enterostomy should be performed, and if the pylorus is much indurated and nodular it should be freely removed (pylorectomy), as the diagnosis from malignant growth is most uncertain. Where the patient is much emaciated and weak it may be well to perform the anastomosis alone at the first operation and later reopen and explore the pylorus, when if the ulceration is simple it will most likely be much less indurated. Pyloro-plasty for this condition is seldom advisable as recurrence is very common, since the process of ulceration is often unhealed.

Where the stenosis is due to extrinsic adhesions it may suffice to divide these, though in most instances a gastro-jejunostomy should be done as well. For the condition hour-glass stomach the operation varies with the condition present ; in most instances the best method will be to perform a gastro-enterostomy into the proximal pouch, care being taken that the proximal pouch really is drained. Where this pouch is small the operation may be difficult, as the pouch is tucked up under the diaphragm.

Gastroplasty is only advisable where there is no thickening of the stomach at the seat of stenosis, which is uncommon : this operation consists in

splitting the stricture longitudinally and suturing it transversely as in pyloroplasty.

Gastro-gastrostomy consists in joining the two pouches together by anastomosis, and is only advisable where the pouches are large and easily approximated. *Excision* of the stenosed portion is only advisable where the condition is malignant, as it is very difficult and carries a high mortality.

Where there is pyloric stenosis as well as stenosis of the body of the stomach a gastro-jejunosotomy should be done into each pouch. Gastro-jejunostomy has the advantages of promoting healing of the ulcer, which is often still active, as well as efficiently draining the stomach, but the proximal pouch must be drained.

(5) *Perigastritis.* Perigastritis, or peritonitis around the stomach, usually results from ulceration of the stomach, and may be suppurative or plastic and fibrosing in nature. The suppurative varieties have been sufficiently described under Subphrenic Abscess and Perforation of Gastric Ulcers ; it remains to consider the plastic, fibrous type. Adhesions around the stomach are more often due to chronic than acute ulcers, and are most common about the pylorus and on the posterior surface—in the latter position causing the stomach to be fixed to the pancreas and offering a great obstacle to healing, since the stomach-wall cannot contract down and so lessen the size of the ulcer.

Adhesions about the pylorus may cause stenosis, while if on the anterior surface they may fix the organ and cause pain when they are dragged on by movements of the stomach. Such bands should be divided, which often relieves the symptoms ; when possible the ulcer should be excised and gastro-enterostomy performed : treatment for stenosis has been described.

DUODENAL ULCER. *Symptoms.* These resemble those found with gastric ulcer as to pain, fullness after meals and acid eructations. Very characteristic of this disease is the hunger-pain at night already mentioned. The patient is usually a man of thirty and over, well nourished, able to eat anything, and vomiting is almost unknown. As regards signs, there is the high total acidity and high percentage of free hydrochloric acid in the gastric contents, tenderness on the right side of the epigastrium, and sometimes melæna, which may lead to severe anæmia.

The cause of the hunger-pain is supposed to be a reflex contraction of the pylorus of a cramp-like or colicky nature, caused by the highly acid gastric juice flowing over the raw surface of the ulcer.

The symptoms intermit more frequently than do those of gastric ulcer, and this, together with the well-nourished appearance, good appetite, freedom from vomiting and hunger-pain at night, with tenderness of the right side rather than the left, will help to distinguish from gastric ulcer, though it must be confessed that cases often turn up in which this distinction is far from easy.

Treatment. Where no complications are present the treatment is as for gastric ulcer, viz. rest in bed and careful dieting, large dose of alkalis ; but should the ulcer be chronic or recur in spite of medical treatment,

a gastro-enterostomy should be done and the pylorus occluded by sutures, while as a safeguard the appendix may be also removed, since chronic infection of this portion of the intestine is most probably the starting-point of ulceration of the duodenum.

The complications are treated on similar lines to those of gastric ulcer, viz. :

(1) *Perforation* by suturing and gastro-enterostomy.

(2) *Bleeding* by excision of the ulcer or infolding the duodenum till it is occluded, followed by gastro-enterostomy ; while (3) *stenosis* is also treated by gastro-enterostomy.

DILATATION OF THE STOMACH ; GASTRECTASIS. This falls into two main divisions, acute and chronic.

(1) *Acute Dilatation of the Stomach.* Acute dilatation of the stomach is described here for convenience, but it must be pointed out that in many respects it bears a close resemblance to acute intestinal obstruction or ileus, occurring very high up the intestinal tract—in fact in the duodenum.

This is a somewhat uncommon condition, sometimes arising from no obvious cause or in the course of some wasting disease, such as chronic renal affections or diabetes, or after operations under anæsthesia, especially those on the abdomen.

Anatomy. The stomach is hugely dilated, and the dilatation does not end at the pylorus as in conditions of chronic dilated stomach, but extends well below the biliary papilla to the last part of the duodenum. In some instances the dilatation ends just where the superior mesenteric vessels cross the last part of the duodenum, and in such cases it is found that the mesentery is stretched and over-long so that a coil of small intestine is prolapsed into the pelvis, the duodenum being blocked by the pressure of the tense mesenteric vessels, but in other examples the dilatation extends below the crossing of the mesenteric vessels, and it is thought (Box and Wallace) that an atonic stomach prolapses and kinks the duodenum and this causes the latter to become obstructed, so that from being merely atonically dilated the stomach passes into the acutely dilated condition, *i.e.* intestinal obstruction at the duodenum ensues.

Signs. The onset is sudden, large quantities of green bilious liquid being vomited ; the abdomen is greatly distended, especially in the epigastrium, and the patient becomes collapsed, with subnormal temperature.

Treatment. The stomach should be frequently emptied with the stomach-tube and the patient kept on his face or in the knee-elbow position to obviate the drag of the mesentery or the pressure of the dilated stomach on the duodenum, while strength is maintained with saline solution given per rectum and strychnine hypodermically to increase the tone of the viscus. Operative measures are seldom satisfactory unless adhesions are the cause, which is quite unusual. The prognosis is grave, about 75 per cent. of cases dying.

(2) *Chronic Dilatation of the Stomach.* This may be due to :

(1) Muscular atony of the stomach.

(2) Stenosis of the pylorus, which may be simple (inflammatory), congenital, and malignant.

The signs have been described under Stenosis of the Stomach secondary to Gastric Ulcer, viz. large, infrequent, fermented vomits, visible dilatation of the stomach, visible peristalsis, succussion plash, observations of bismuth meals, wasting, and *tetany*. The latter condition deserves further mention, being a sign that the condition is grave and operative measures necessary. The spasms are tonic, lasting some hours, the forearms being flexed, the fingers extended and adducted together, while the thumb is firmly rotated into the palm (accoucheur's hand) ; the knees are extended and the feet in the position of plantar-extension. The muscles are unusually excitable, spasms being increased by striking or compressing the latter.

Treatment. As in many instances it will be uncertain whether patients presenting these signs are suffering from simple atony of the stomach or stenosis, treatment should be at first on medical lines, washing out the stomach daily, giving small and readily digested meals, together with attention to the bowels and administration of strychnine. Where such treatment fails after a few weeks, or where the condition has come on suddenly, suggesting the possibility of pyloric cancer, or where there is much emaciation or tetany, the abdomen should be explored by laparotomy, and if the case be one of simple pyloric stenosis or atony, gastro-enterostomy performed ; but where the condition is cancerous a wide excision of the pylorus (*see later*) will be indicated.

Dilatation from simple fibrous stenosis of the pylorus has been already discussed, while that due to cancer is described in the next section ; there remains to be mentioned the congenital form.

CONGENITAL HYPERTROPHIC STENOSIS OF THE PYLORUS. This is an affection leading to chronic dilatation of the stomach, usually occurring in small infants, though it is possible that cases of similar pathology occur in later childhood or young adult life ; such, however, are rare, while the infantile type is far from uncommon, though often undiagnosed. As to ultimate pathology, it is uncertain whether the overgrowth of the pylorus is a hyperplasia or a true hypertrophy from pyloric spasm ; the former view seems the more correct.

Anatomy. There is great thickening of the muscular tissue of the pyloric ring both in length and thickness, the pylorus being of the size and consistency of an acorn and the pyloric channel correspondingly diminished so as to only admit a probe with difficulty. It may be noted, however, that the mucosa is not diminished in extent but remains puckered up into many folds from the small calibre of the surrounding muscle. The stomach is dilated and hypertrophied from its efforts to drive its contents through the pylorus, while the small intestine below is contracted and tiny by contrast. Less commonly the pylorus is simply stenosed without any hyperplasia.

Signs. Usually the infant is born healthy, but after a few weeks, less often after a few months, vomiting of food commences (the condition is

as common in breast-fed babies as those brought up by hand). The vomiting becomes steadily worse both in amount and frequency in spite of all alterations in diet, and when well established is of a characteristic nature, the contents of the stomach being very forcibly expelled (propulsive) and may be ejected to a distance of three feet or more ; the vomiting comes on shortly after feeding. The infant wastes rapidly and the distended stomach is clearly visible, especially after a feed, in the emaciated abdomen, while peristalsis is easily seen. In some instances (about half) the acorn-like tumour can be felt through the thin abdominal wall. Constipation is marked but there are no signs of enteritis as in other conditions affecting the gastro-intestinal tract. Later, as the fluid in the tissue diminishes, retraction of the head and syncopal attacks usher in the end. Where the stenosis is very complete the motions retain the character of meconium for many weeks.

Treatment. In the early stages while the diagnosis is uncertain the stomach should be washed out twice a day with dilute solution of sodium bicarbonate and the feeds should be small and frequent, peptonized to commence with and well diluted. Where the condition is fairly certain, operative measures should not be delayed. Where there is dilatation of the stomach and propulsive vomiting, whether any tumour can be felt or not, a small laparotomy is advisable, and if the pylorus be not stenosed and hyperplastic the abdomen may be closed. Indications for immediate operation are passage of unaltered meconium for several weeks after birth or syncopal attacks and head-retraction from insufficient fluid in the tissues. On the whole, medical measures are not very successful, judging from cases seen treated in hospital, and we have little doubt that many cases reported as cures were not correctly diagnosed. Early operative measures hold out a good prospect of success, and this is the more indicated as there is reason to believe that the hyperplastic condition persists for months after the distension of the stomach has been relieved by operation. The main mortality in these subjects is due to delaying the operation till the patient is very weak. The operation of choice is a posterior gastro-enterostomy, as this surely relieves the obstruction and is an operation which surgeons

Fig. 46. A, Congenital stenosis of the pylorus, showing great thickening of pylorus and dilatation of the stomach. B, Stomach of normal infant of the same age C, Section through pylorus, showing puckered mucosa and thickened muscle.

are constantly performing, and which can therefore be done with rapidity (the whole proceeding, from opening the abdomen until it is closed, taking little over twenty minutes). Good results are reported by dilatation of the pylorus (Loreta's operation) and pyloroplasty ; from what we have seen of these cases we advise gastro-enterostomy, as being less difficult and dangerous. Shock is prevented by administration of saline infusion before and after operation and early administration of small feeds.

CANCER OF THE STOMACH. Cancer of the stomach is tolerably common, this organ being affected next in frequency to the uterus and being the organ most frequently affected in the male, in whom it is rather more common than in females. This is essentially a disease of middle and old age, being rare before forty, though cases do occur in the second decade.

Of predisposing causes the most important is chronic gastric ulcer, though the real number of cases of ulcer which become cancerous and, conversely, of cancer which are due to ulcer, is uncertain. Thus medical authorities give the percentage of cases of cancer with a previous history pointing to ulcer as quite small, while the findings from the Mayo clinic point to ulcers as being the precursors of cancer in most instances, viz. that ulcer preceded cancer in about 80 per cent. of cases. The microscopical diagnosis of early cancer supervening in cases of ulcer is, however, neither easy nor unequivocal, and it is probable that the figures given thus are far too high ; still the fact remains that simple ulcers are definite precursors of cancer of the stomach just as they are elsewhere (e.g. in the tongue), and their removal is indicated where not too dangerous. Cancer may occur in any part of the stomach, but more than half the cases are found to commence close to the pylorus.

Microscopically the growth may be an adenocarcinoma of the columnar-celled form or more usually a spheroidal-celled cancer which may be of the encephaloid, scirrhous, or colloid variety.

The size and shape of the organ are altered by the growth. Thus if near the pylorus there will be blocking of this outlet and dilatation with hypertrophy of the main part of the stomach. Growth of the body may invade the whole organ, which shrinks and becomes thickened—" leather-bottle stomach " (it is held by some that this condition may be also due to chronic, simple fibrosis of the organ, but the more general view is that this is a scirrhous cancer in which there is much fibrous tissue and a very slight amount of cellular, cancerous elements).

In other instances cancer of the body may be more localized and lead to stenosis of the body of the organ, one form of hour-glass stomach. Finally, where the growth is at the cardiac orifice the opening of the œsophagus is obstructed and the body of the stomach becomes small and atrophic, lying close up under the diaphragm as in cancer of the œsophagus.

SPREAD OF GASTRIC CANCER. This is by the tissue-spaces, lymphatics and blood-stream ; hence a brief description of the lymphatic arrangements of the stomach will be of help (Jamieson and Dobson). The blood-vessels

of the stomach are the key to the lymphatics, which for the most part run with the former.

The blood-vessels form two arcades along the greater and lesser curvatures respectively. That of the lesser curvature in the gastro-hepatic omentum is formed from the coronary artery running down from the œsophageal opening and meeting the pyloric branch of the hepatic artery coming from the pylorus. On the greater curvature, in the great omentum, is the right gastro-epiploic, derived from the hepatic artery running from the pylorus to the left, where it joins the left gastro-epiploic branch of the sphenic artery : the vasa brevia of the splenic artery run up over the fundus inosculate with the œsophageal branches of the coronary,
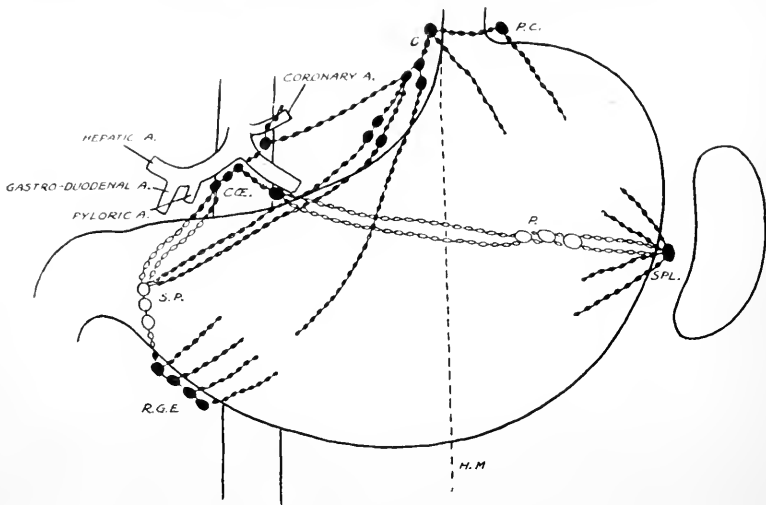
Fig. 47. Lymphatic arrangements of the stomach. CŒ, Glands about cœliac axis. S.P., Subpyloric glands. R.G.E., Right gastro-epiploic glands. P, Pancreatic glands along splenic vessels. P.C., Paracardial glands. H.M., Hartmann-Mickulicz line. The dark lymphatics and glands are in front, the pale behind the stomach. C, Coronary glands.

and so complete the circle. Lymphatics from the pyloric and pre-pyloric part of the stomach run along the coronary artery to the left, to two groups of glands along the coronary artery, the upper and lower coronary glands, whence efferents pass on to the aortic glands around the origin of the cœliac axis. Other lymphatics run from the same parts of the stomach to the glands below the right part of the stomach, along the right gastro-epiploic artery and into a group of glands further back behind the pylorus between the junction of this vessel with the gastro-duodenal, called the subpyloric glands, whence efferents pass along the hepatic artery to join the aortic glands around the cœliac axis. A few lymphatics run from the pylorus along with the pyloric artery to the cœliac glands via the hepatic artery, with or without the intervention of one or two pyloric glands.

From the body and fundus of the stomach the lymphatics drain into the splenic glands lying between the stomach and spleen in the gastro-splenic omentum on the artery of that name, and thence along the splenic

artery above the pancreas, passing through groups of pancreatic glands to join the cœliac glands.

From the fundus of the organ some lymphatics also drain into the glands around the cardiac orifice (paracardial glands) and thence into the superior coronary group.

The growth in the stomach itself spreads along from the pylorus towards the body, particularly along the lesser curvature, as might be supposed from the arrangement of the lymphatics ; there is practically no tendency to spread to the duodenum, although the submucous lymphatics of the stomach and duodenum are continuous. The glands involved are both coronary sets, those of the right gastro-epiploic and subpyloric sets, while from these groups or direct from the stomach, cancer-cells may pass to the glands around the cœliac axis. From the body of the organ the spread is to the splenic, paracardial, and coronary glands.

The liver is affected through the portal blood-stream or by communications between the cœliac and subpyloric glands with the biliary glands along the hepatic artery.

Finally cancer may spread to the peritoneal coat and soon be disseminated all over the peritoneum, and by this means or by spread from the right gastro-epiploic glands the great omentum is affected.

Physical Characters of the Growth. In most instances the condition is that of an ulcer with hard, puckered, everted edges and indurated base often fixed to surrounding organs. If the ulcer is small and the edges not much everted it cannot be distinguished with certainty from a chronic simple ulcer.

In the leather-bottle type ulceration is slight or absent, the growth being then a dense infiltration of the wall with fibrous tissue. In less common cases the growth may be polypoid in character.

In general, cancer of the stomach is of relatively low malignancy, spreading less rapidly to glands and other organs than cancer of the breast, and therefore if diagnosed and removed early there is some prospect of cure.

Perforation of a cancerous ulcer sometimes occurs, the signs being as for the similar complication of simple ulcers.

Symptoms and Signs. Cancer of the stomach may appear under a number of disguises, such as anæmia, wasting, weakness, and many of these " latent " cases escape the acumen of the physician till the truth is revealed on the post-mortem table. Since the only curative treatment is surgical, and for this to be effective early diagnosis is essential, it behoves us to investigate carefully the functions of the stomach in all persons of middle age or over who present such symptoms, and *a fortiori* of those who in addition complain of dyspepsia as well ; nor must we shrink from early exploratory laparotomy as a means of diagnosis where there is any reasonable suspicion of this disease. *Dyspepsia* is commonly an early symptom and of varying nature.

Nausea and *anorexia, i.e.* distaste for food, especially meat, is a common early symptom.

Pain situated in the epigastrium, usually made worse by taking food and relieved by vomiting, is usual, and is more constant and not of the severe paroxysmal and intermittent type found in cases of simple ulcer.

Vomiting may be entirely absent but is more commonly present, especially if the growth be at one of the orifices of the organ. Thus in cases of cancer of the pylorus the vomiting soon has the characters described as found when the stomach is dilated, whereas if the cancer affects the cardiac orifice the regurgitation of food is akin to that found in œsophageal obstruction rather than real vomiting.

Blood in the vomit is common but in small quantities, and altered by digestion to a brownish-black, grouty material (coffee-ground vomit).

Abdominal examination may reveal a visible or palpable hard tumour in the epigastric region, resonant and at first mobile on respiration. Such a tumour shows the condition is advanced, yet about half of such cases are operable. If the tumour is pyloric the signs of dilated stomach will be noted. Subcutaneous nodules about the umbilicus, nodular enlargement of the liver, and free fluid in the peritoneum point to a wide spread and inoperability of the growth. Examination of the gastric contents will often give much help.

Absence of free hydrochloric acid and a low total acidity in a case of a few months duration strongly suggests cancer, but where the symptoms have been present for some years the condition is more likely atonic gastritis with dilatation, gastroptosis, or gall-stones.

Increase of general acidity and of hydrochloric acid is usual in cancer commencing on a chronic ulcer.

Loss of motile power of the stomach, the presence of altered blood and hæmin crystals, are suggestive of cancer, while fragments of growth may disclose the type present. Fermentation and various yeasts are found in any chronic dilatation of the organ and not especially in cancer.

General Signs. Progressive emaciation is very usual, and in middle-aged persons is highly suggestive of cancer of the stomach. Loss of strength goes with the loss of weight.

Anæmia of the secondary type, *i.e.* associated with leucocytosis, is common, and the pale yellow appearance of the patient resembles that found in cases of pernicious anæmia.

Later Signs. Jaundice, ascites, œdema of the legs, effusion into the pleura, enlarged glands in the supraclavicular triangle, nodules in the liver and about the umbilicus, are indications that the condition has passed beyond the stage when cure is possible.

Diagnosis. Where dyspepsia commences suddenly in a middle-aged person without other disease to account for it such as phthisis, renal or cardiac affections, and resists medical measures for a few weeks, exploratory laparotomy should be advised, especially where the acidity of the gastric contents is low and traces of blood are found in the latter, for early diagnosis and operation is the only hope. Diagnosis at operation is not altogether certain, as chronic ulcers may be so thickened, indurated, and puckered

as to suggest the presence of cancer ; enlarged glands are not of much assistance unless very great, since these are often enlarged in cases of chronic ulcer and may not be obviously affected in early cancer.   Unless the surgeon is very confident that the condition is one of simple ulcer it will be best to perform a partial excision of the stomach in such cases.

Treatment.   To give a reasonable prospect of cure or prolonged pallia-tion it is necessary to remove a wide area of the organ about the growth and the areas of lymphatic drainage as far as possible.   This can only be done with accuracy when the growth originates in the pyloric region, for-tunately a common situation.   The results here are distinctly encouraging, life being prolonged with comfort for two to three years or in favourable cases complete cure resulting.   Operations of a purely palliative type, such as gastrostomy, gastro-enterostomy, jejunostomy, may be occasionally employed in selected cases.

Pylorectomy or Partial Excision of the Stomach for Cancer. The part removed is the stomach from the pylorus, including the com-mencement of the duodenum to a line joining the right of the cardiac orifice with the point immediately below this on the greater curvature (Hartmann-Mickulicz line).   In addition the lesser omentum, including the coronary glands, the upper part of the great omentum, including the right gastro-epiploic and subpyloric glands, are removed. Contra-indications are secondary nodules in the liver and adherence of the organ, particularly to the pancreas, and to ascertain this the finger should be slipped into the lesser sac.

Operation.   The small omentum is tied in sections and divided close to the liver ; the coronary artery is divided between ligatures as it comes off the posterior abdominal wall and above the coronary glands ; the pyloric artery is similarly divided near its origin.   The stomach can now be drawn out of the abdomen and the gastro-duodenal artery, and the left gastro-epiploic artery at the lower end of the Hartmann-Mickulicz line secured and divided.   The great omentum is stripped from the transverse colon, taking care not to injure the middle colic artery, or gangrene of the colon is likely.   The stomach is now free of its mesenteric attachments and the first part of the duodenum is crushed and divided between ligatures and the distal end invaginated with a purse-string.   Large clamps are placed across the body of the stomach at the above-mentioned line and the organ divided and the pyloric part removed.   The stump of the stomach is then closed with two layers of continuous sutures, an inner of chromic catgut, an outer of silk.   The upper part of this suturing, near the cardiac orifice, may be difficult and require curved needles and much retraction ; in difficult cases there should be no hesitation in dividing the rectus transversely to the left in order to give more room.   The operation is completed by bringing up the commencement of the jejunum through the transverse mesocolon and anastomosing this with the most dependent part of the stomach by a posterior gastro-enterostomy.   This is much safer and easier than attempting to join the cut ends of the stomach and duodenum.

This operation may be performed in two stages, the anastomosis being made first and the patient being well fed through this for three weeks to restore his stamina before the more formidable operation of excision is performed. This is seldom advisable except where the diagnosis is uncertain, and then should be accompanied by local excision of the ulcer for diagnostic purposes.

After-treatment consists in combating shock by administering plenty of saline per rectum and feeding as in other abdominal operations. The mortality varies from 14 to 30 per cent., and 15 per cent. of cases are alive more than three years after, while should these patients succumb, life is prolonged in fair comfort for two years, compared with those which are left untouched.

TOTAL GASTRECTOMY. By slanting the line of section of the stomach more to the left and tying the left gastro-epiploic artery nearer to its origin more of the organ may be removed for cases where the growth encroaches on or starts in the body ; finally the whole, or nearly the whole, of the organ may be removed with the glands in the gastro-splenic omentum and round the cardia, as well as those previously mentioned. The main difficulty in such cases is to unite the stomach or œsophagus with a loop of the jejunum. The mortality of published cases is 36 per cent., the after-results being in many cases excellent.

OTHER OPERATIONS FOR CANCER OF THE STOMACH. Gastro-enterostomy should be performed where there is cancer of the pylorus which is not removable and is causing dilatation of the stomach, for although life is not prolonged for more than three months on the average by this measure, yet the greater comfort of the patient renders it well worth performing.

Gastro-enterostomy is of little benefit for cancer of the body of the organ, though where there is marked loss of motor-power some relief may be brought about.

In cases where the patient is greatly emaciated and there is some urgent reason for attempting to prolong life for a few weeks it may occasionally be justifiable to feed through the jejunum (jejunostomy).

Gastrostomy will relieve from immediate starvation where the disease is at the cardiac orifice and the condition is practically that of œsophageal obstruction.

Where operative measures are out of the question relief may often be given by washing out the stomach daily with dilute bicarbonate of soda and administering one-eighth to one-quarter of a grain of morphia at night, while bicarbonate of soda, bismuth-carbonate, creosote, and carbolic acid given by mouth are helpful.

OPERATIONS ON THE STOMACH. (1) LAVAGE, or washing out the stomach, is best done by means of a tube of half-inch bore and a yard long with a funnel at the upper end. This tube is lubricated and passed down the gullet, the patient being asked to attempt to swallow while the head is kept in the flexed position. Warm water or dilute bicarbonate solution is poured down through the funnel, the tube is nipped and the funnel lowered, which syphons off the gastric contents.

The stomach-tube is used for many purposes :

(*a*) For diagnosis in removing a test meal as described.

(*b*) To remove poisons ; but never where the poison is corrosive, lest the eroded stomach be burst by the pressure of fluid inside.

(*c*) To clean the organ as a preliminary to operations on the stomach.

(*d*) As treatment for cases of acute or chronic dilatation of the stomach, and in the urgent or fæcal vomiting for intestinal obstruction and peritonitis.

Frank's

(2) GASTROTOMY, or opening the stomach, as employed for removal of foreign bodies, has been described ; this is also useful for removing foreign bodies from the lower end of the œsophagus. The operation has been used as a preliminary to dilatation of the œsophagus or pylorus from within ; the latter operation (Loretta) is seldom used at present, but various forms of stenosis of the lower œsophagus, *e.g.* cardio-spasm, may be treated from below by this route (*see* p. 135).

Kader's.

The stomach may be opened to arrive at a bleeding-point, but only if the site of the ulcer can be determined from outside the organ. It should be noted that a large part of the gastric mucosa can be evaginated through an opening in the anterior wall of the stomach with the fingers behind in the lesser sac.

Witzel's.

(3) GASTROSTOMY. This implies the formation of a fistula between the stomach and the surface of the body, through which the patient may be fed in cases of intractable stenosis of the pharynx, œsophagus or cardiac orifice, usually due to cancer. The main points of a satisfactory

Marwedel's.

FIG. 48. Gastrostomy (various methods).

method are : (*a*) That the patient may be fed at once (which is often important in these emaciated subjects). (*b*) To avoid any risk of leakage of gastric juice, causing the wound to break down and leaving the patient in a pitiable condition. This last consideration is attained by two plans. Either a long fistulous tract is made by pulling a portion of stomach through the abdominal wall and undermining the skin, as in the methods of Albert and Frank, or the opening is made valvular and opening inwards as in the Senn, Kader Witzel, or Marwedel procedures. As there seems to be no question that the latter type of operation is the best, its varieties alone will be described, the method of Frank can readily be followed by the diagram, but is not recommended, as liable to leakage (Fig. 48).

(1) The method by which the stomach is invaginated round a catheter like a " non-spilling inkpot " (Senn, Kader, Abbe), has the merit of simplicity and efficacy. The stomach is exposed by a two-inch incision, splitting the upper fibres of the left rectus (local anæsthesia with novocain is advisable in debilitated subjects). Three concentric purse-string sutures of silk are inserted in the stomach-wall, the diameter of the smallest circle being half an inch, the others a quarter of an inch outside this. The tube (No. 12 soft-rubber catheter) is inserted through a small hole made in the centre of the purse-string sutures and these are tightened in turn, beginning with the most central. In this way the stomach wall forms an inverted cone where pierced by the feeding tube and a most efficient valve is formed. The stomach is secured to the posterior layer of the rectus sheath and peritoneum above and below the point of entry of the tube and the abdominal wall closed in layers. If the stomach be much retracted so that it will not come up to the abdominal wound, the peritoneum is stripped from the latter and turned down to reach the stomach, to which it is secured with a few sutures (Fig. 49).

FIG. 49. Gastrostomy by the invagination method, showing the method of fixing in the catheter.

(2) In Witzel's method the tube is inserted through a small hole into the stomach and a continuous suture passed, bringing the peritoneal coat of the stomach over the tube as shown in the diagram, the result being that the tube passes obliquely through the wall of the stomach and the latter is attached to the abdominal wall as before.

(3) Marwedel's method is very similar : the stomach is incised through the serous and muscular coats for about two inches. The tube is introduced through a small hole at one end of the incision, the edges of which are then sutured over the tube, thus again forming an oblique opening for the passage of the tube. These last two methods may be useful where the stomach is very small and retracted so that there is not much tissue for making the larger invagination needed in the " inkpot " method, though in our experience the latter is simple and satisfactory. As soon as the operation is complete two ounces of egg-and-milk may be poured down the tube, and after each feed a little water is poured through so that the tube may not be blocked with curds. The feed can soon be augmented till the patient is on a full liquid diet. Care must be taken not to remove the tube or the fistula will be rapidly occluded with adhesions and re-introduction be difficult.

It is well to remember that the stomach is smooth-walled and has no appendices epiploicæ or muscular tæniæ, for opening the colon by mistake is not unknown.

(4) PYLOROPLASTY, ETC. This operation is the archetype of all operations bearing this termination, and consists in dividing a stenosis of the
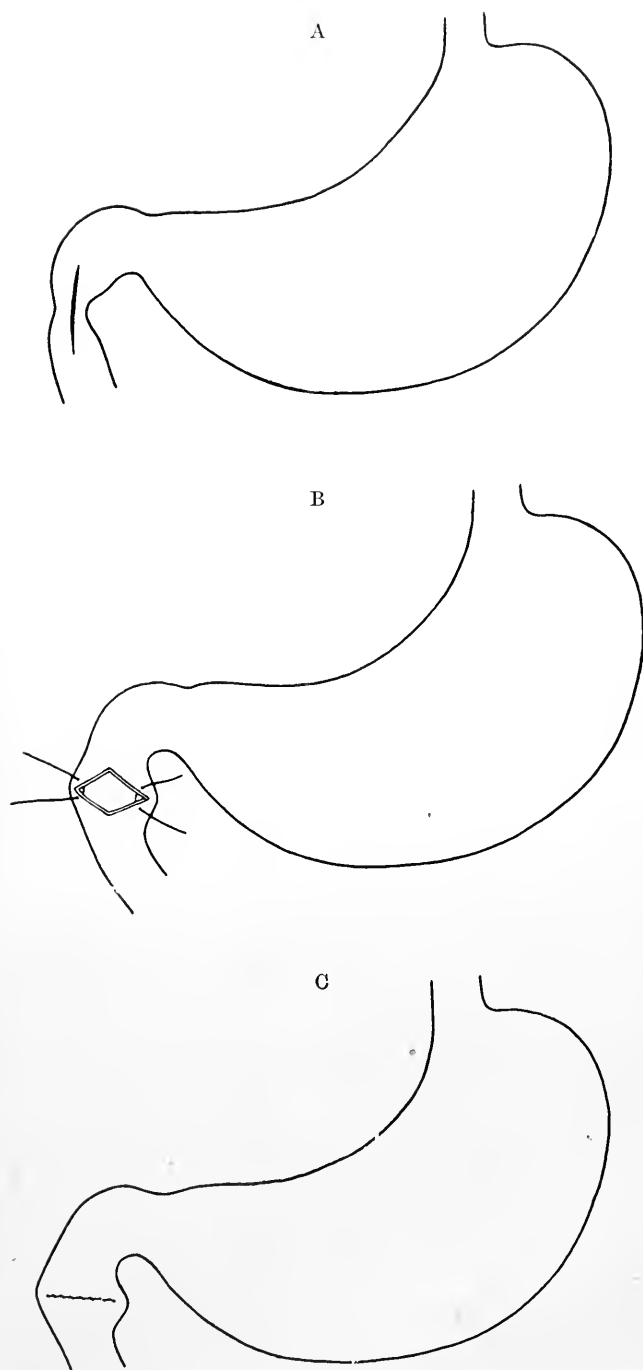
FIG. 50.   A, Pyloroplasty, showing the incision to obviate pyloric stenosis.
B, Suturing the opening in pyloroplasty at right angles to the original incision.
C, Completion of a pyloroplasty.

pylorus by a longitudinal incision passing from the stomach to the duodenum, pulling the edges apart and suturing again transversely. This operation is seldom advisable, since the stenosis is apt to recur as the fibrous tissue is still contracting and the ulcer often not completely healed. Moreover, the drainage for a dilated stomach is less good than that provided by gastro-enterostomy, while the reduction of the acidity of the gastric contents and alteration of the gastro-duodenal secretion reflex are not affected to such a satisfactory degree as with the more radical operation.

Finney's operation, which is a sort of glorified pyloroplasty, and gastro-duodenostomy, have been performed with the idea of sending the gastric contents into the small intestine above the biliary papilla and to prevent the regurgitation of bile into the stomach. There seems little need for these refinements, and the passage of intestinal contents into the stomach, which occurs in all gastro-enterostomies, is beneficial in neutralizing the gastric juice. These operations rather mark a stage in the surgery of the stomach and require no more than mention.
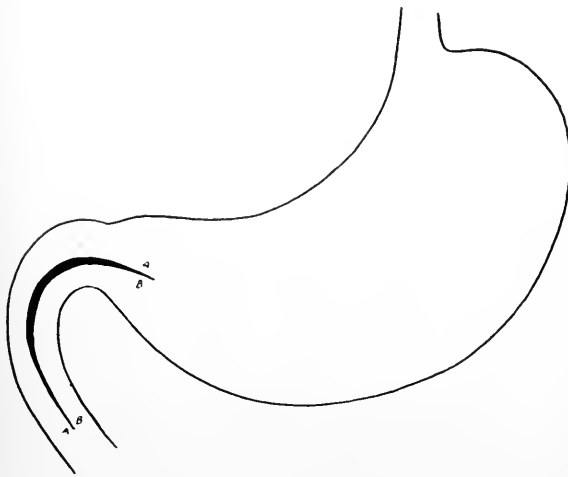
(5) The same remark applies to gastroplication, or reefing up the stomach with sutures like a Venetian blind, which has been employed for atonic dilatation. The careful use of the stomach-tube and, failing this, gastro-enterostomy, are more successful.

Fig. 51.   Enlarging the pyloric canal by Finney's operation.

Gastrorrhaphy, or slinging up the prolapsed stomach, is discussed later under Visceroptosis, &c.

(6) GASTRO-JEJUNOSTOMY. The formation of a fistula between the stomach and the jejunum is the keystone of gastric surgery, and though not quite the panacea for all dyspeptic ills that its early advocates believed, yet holds its place as one of the most successful operations of modern surgery.

This operation has passed through many modifications since the days of the anterior long-loop operation of Wölfler to the present posterior no-loop method, which gives results well-nigh perfect. The object of the fistula is to allow a ready passage of gastric contents into the highest part of the small intestine in order to lose as little of the absorbent surface as possible, while at the same time excluding or short-circuiting the pylorus and duodenum. In this way escape of highly acid gastric contents is allowed, diminishing spasm of the pylorus and the associated pain : the

stomach and duodenum are rested, allowing ulcers to heal, and the free opening of the intestine into the stomach helps to neutralize the gastric juice with the alkaline bile and intestinal juices and further reduce the acidity of the stomach.

Indications. (1) Stenosis of the pylorus :

(*a*) Simple, from ulceration.

(*b*) Malignant, where excision is impossible.

(*c*) Congenital hypertrophic stenosis.

(2 Where there is dilatation of the stomach due to atony or malignant growth, if this be not remedied by washing the organ out with the tube daily, or where there is tetany.

(3) For chronic or recurrent ulcers of the stomach and duodenum which do not yield to medical treatment, and then combined with excision or infolding the ulcer and removal of the appendix.

(4) In cases of hæmorrhage from gastric ulcers, either alone, if the point cannot be found, or in addition to infolding or suturing the bleeding ulcer.

(5) To complete the operation of pylorectomy or partial gastrectomy.

FIG. 52. A, Position of stoma in a gastro-enterostomy of the Mayo type. *b*, Position of the stoma in iso-peristaltic gastro-enterostomy.

(6) For hour-glass stomach, when the stoma should always be into the proximal pouch, and into the distal as well where in addition there is pyloric stenosis.

Preliminary Considerations. The mouth should be rendered clean by removal of stumps and tartar, and the use of the toothbrush and antiseptic mouth-washes for several days beforehand to diminish the risk of infection of the suture-line.

Where the stomach is imperfectly emptied it should be washed out three hours before operation, and if the patient's condition be weak saline per rectum should be administered one hour before operation. Where there is hæmatemesis or perforation, of course the wash-out should be avoided, though a stomach-tube may be passed under the anæsthetic to avoid inhalation of vomited matter. The stoma should be vertical in direction, parallel to the vessels, and situated at the lowest part of the stomach close to the junction of the body of the organ with the pyloric part, to secure good drainage. The length of the stoma should be three inches, certainly not less than two and a half, or it will become too narrow to be of any use. The advisability of using clamp-forceps has been pointed out already, while both organs should, if possible, as is usually the case, be drawn outside the abdominal wall, so that straight needles may be used. In nearly every case sutures should be employed to unite the stomach with the small intestine; rarely, where there is great difficulty from the organs being fixed down by adhesions, a Murphy's button may be useful. Suturing is done as in performing lateral anastomosis elsewhere, an internal layer row of continuous chromic catgut and an outer peritoneal row of fine silk. There are various methods of anastomosing the stomach and jejunum either in front or behind the transverse colon, with the addition of valvular arrangements or further anastomosis between the small intestine above and below the stoma, but these additions are unnecessary in most instances if the posterior method without a loop be employed, and are only advisable where the latter method is impracticable.

FIG. 53.   Gastro-enterostomy, opening the mesocolon.

Posterior No-Loop Gastro-jejunostomy, without reversal of the Jejunum (Mayo). The abdomen is opened by a paramedial incision through the upper part of the right rectus and the stomach, duodenum, gall-bladder, and pancreas carefully examined before going further; for the diagnosis is seldom complete before local inspection has been made, and it is humiliating for the surgeon to perform gastro-enterostomy when the real trouble is gall-stones. The great omentum and transverse colon are drawn out

of the abdomen and the lesser sac entered through the transverse meso-
colon to the left of the middle colic artery in a bloodless part (Fig. 53). The
posterior wall of the stomach is brought out and secured with the long
intestinal clamps placed with the handles vertical and to the left (Fig. 53A).
Next the origin of the jejunum is found and placed in an intestinal clamp
and the stomach clamped and brought parallel to this, the handles being held
by the assistant. The anastomosis is made (Fig. 54) in the usual manner, viz. :

(a) Uniting the peritoneum of both organs with continuous silk.

(b) Opening the organs
one-eighth of an inch
away from the suture-line
and removing redundant
mucosa from the edges of
the opened viscera.

(c) Suturing the viscera
together with chromic gut,
which passes continuously
through all coats and acts
as the apposing and hæmo-
static agent. This layer
is inserted in two rows
along either edge of the
aperture made in the
viscera, the rows being
knotted together at their
ends so that the suture
runs all round the stoma,
which is then complete
but needs,

(d) the superficial row
of continuous silk to

Fig. 53A. Stomach pulled through mesocolon, held in
clamp forceps, as is also the jejunum.

bury the deep layer of stitches, and which takes up peritoneum
only.

(e) The clamps are removed and the anastomosis is complete, but the
aperture in the transverse mesocolon must be carefully occluded by suturing
the mesocolon all round the aperture to the stomach with interrupted
sutures ; if this be not done loops of small intestine very readily prolapse
through into the lesser sac and become strangulated. The plan advised
is better than to suture the mesocolon to the jejunum, as in the latter
method the jejunum may prolapse through the aperture in the meso-
colon and produce kinking of the jejunum at the stoma, and is one cause
of the complication known as " vicious circle."

Some surgeons make the opening in the stomach down and to the right
or transversely and twist the jejunum round so that the efferent loop of
the jejunum comes off the right side of the stoma instead of the left as in
the method described, the idea being that the food then travels in the same

direction in the stomach and jejunum (iso-peristaltic), but there is no evidence that it matters which way the food proceeds once it leaves the
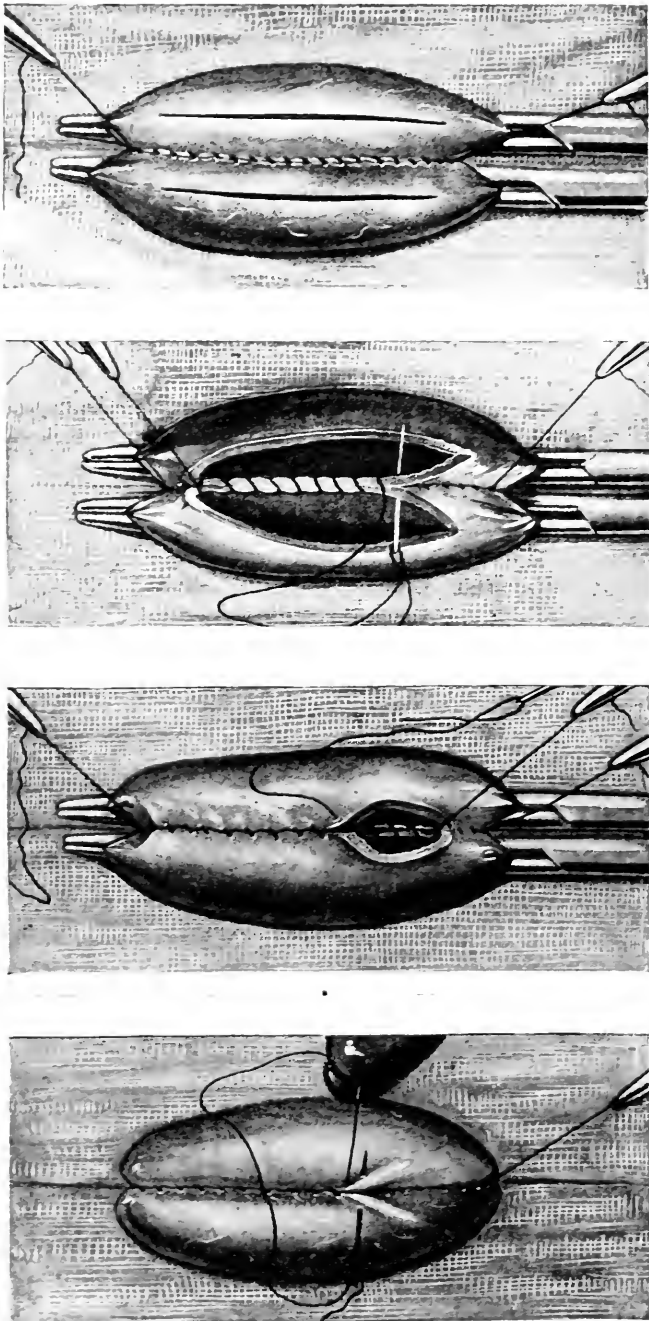
Fig. 54. Stages of gastro-enterostomy.

stomach, and twisting of the jejunum renders kinking more likely than if the above procedure be adopted, for in this method the stomach and jejunum are nearly in their normal anatomical position.

After closing the mesocolon the transverse colon and omentum are returned to the abdomen and the latter closed.

After-treatment. The patient when recovered from the anæsthetic is placed in the Fowler position and fed as in other abdominal operations, viz. for the first twelve hours with hot water only, after which if vomiting has ceased meat-juice and peptonized milk may be commenced in small feeds of one half to two ounces, gradually increased till by the third day four ounces are taken ; then custard and lightly boiled eggs may be given, and after four days pounded fish and thin bread-and-butter, while well chewed meat may be taken after a week.

When it is not possible to make the anastomosis in the posterior wall of the stomach, *e.g.* where the lesser sac is obliterated by adhesions, it must be made in the anterior wall ; the disadvantages are :

Fig. 55.   Completion of gastro-enterostomy, the aperture in the mesocolon sutured to the stomach.

(1) A longer loop of jejunum is needed, and this predisposes to peptic jejunal ulcer ; at any rate, more cases of this complication are recorded after anterior than after posterior gastro-enterostomy.

(2) Vomiting is more likely to follow (vicious circle), as either the afferent or efferent limb of the jejunum may be kinked by the drag of the transverse colon and omentum, or sometimes the jejunum may obstruct the latter, while coils of intestine may prolapse through the aperture which is of necessity formed in this method.

These disadvantages are largely overcome by the *anterior retro-colic* method. In this operation the loop of jejunum is brought from behind forward through the mesocolon and then through the gastro-colic ligament at the root of the great omentum, and so reaches the anterior surface of the stomach, where the anastomosis is made.

COMPLICATIONS OF GASTRO-JEJUNOSTOMY.   (1) *Hæmorrhage.* This may be shown by hæmatemesis or signs of internal bleeding, followed after twenty-four hours by melæna, and may come from an ulcer not properly occluded, or more usually from the anastomosis, owing to some large divided vessel not being thoroughly secured in the inner line of suture. This is

one reason for making the opening nearly vertical and so avoiding most of the vessels and for pulling the deeper sutures thoroughly tight at each stitch. Should the signs of bleeding be severe, as evidenced by great pallor, rapid pulse, air-hunger, &c., and not yield to morphia or administration of adrenalin by mouth (which may be given in dram doses every ten minutes), the abdomen should be reopened and the stomach opened from in front, when the stoma on the posterior surface may be inspected from within and the bleeding-points secured by ligatures or over-sewing and any ulcer thoroughly occluded.

Fig. 56. Posterior no-loop gastro-enterostomy. (The mesocolon should be attached to the stomach, not to the jejunum.)

(2) Severe *bilious vomiting*, usually described as the " vicious circle," following a gastro-enterostomy was formerly at-tributed to the regurgitation of bile irritating the stomach, but bile in the stomach does not produce vomiting, and in all cases of this nature there is some form of obstruction in the upper jejunum due to kinking of the latter.

This vomiting used to be associated with too small a stoma, the anastomosis simply tying up the jejunum while not providing any proper efferent to the stomach. Kinking of the efferent limb of the jejunum occurs in anterior gastro-enterostomy from pressure of the transverse colon or in the posterior operation with reversal of the jejunum from twisting the latter, and we have found kinking due to adhesions follow-ing the operation when done for

Fig. 56A. Anterior retrocolic gastro-enterostomy, suitable if the posterior surface of the stomach is adherent.

a perforated duodenal ulcer where there was a considerable amount of lymph about the site of anastomosis. Kinking may also result from con-

traction of the aperture in the mesocolon, especially where the latter is sewn to the jejunum and not to the stomach. If the operation be performed as described this form of vomiting is extremely rare (Figs. 55, 56).

The condition is shown by repeated large vomits of bile and evidence of a dilated stomach. If not relieved by washing out the stomach at intervals for a few days the abdomen must be opened and the anastomosis explored, adhesions divided, and the stoma, if necessary, enlarged or freed from any kink that may be present : where the afferent loop of jejunum is dilated and the efferent contracted, pointing to stenosis at the origin of the latter, it may be well to make an anastomosis between the proximal dilated limb of the loop and the efferent limb beyond the stoma (enteroanastomosis).

(3) *Intestinal obstruction* may arise from prolapse of intestine through the aperture in the mesocolon or through the loop in the anterior operation. Exploration is urgently needed when such symptoms develop and reduction of the strangulated portion (*see* Intestinal Obstruction).

(4) *Peptic jejunal ulcer* is an unpleasant complication sometimes following gastro-enterostomy, being more common in the anterior type of operation where the stoma is far down the jejunum, and is more usual in the distal
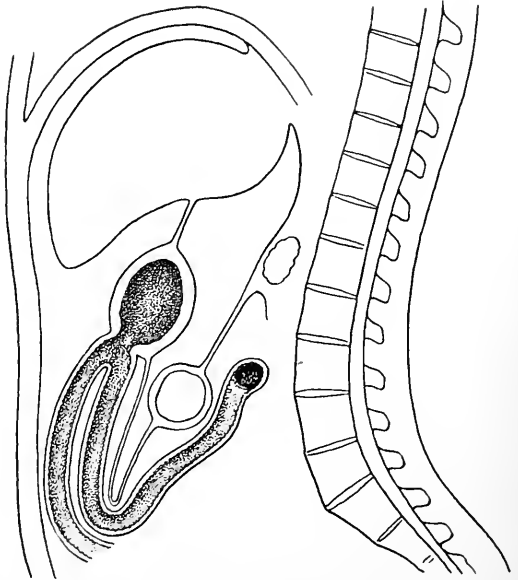
Fig. 56B. Anterior gastro-enterostomy with long loop.

efferent than the afferent part of the latter. The signs are pain in the epigastrium not related to food, vomiting, sometimes tenderness of the epigastrium and a tumour of this region due to adhesions around the ulcer ; perforation sometimes occurs. The ulcer is situated in various parts of the efferent limb of the jejunum, less commonly in the afferent limb, and fairly often at the anastomosis, in which case perforation may take place into the colon, forming a gastro-intestino-colic fistula (Patterson).

Prevention. The posterior no-loop operation is practically never followed by this complication, and the risk is further diminished by administering alkalis after meals for some months following the operation.

Treatment. The patient is carefully dieted, meat being avoided and full doses of bismuth and alkalis given by mouth.

Where these measures fail operative steps are needed, the ulcer being exposed and excised if possible, the stoma being enlarged and measures taken to avoid any kinking of the jejunum.

Two other forms of trouble are described by Hertz. In the first the stoma is too large and the food passes too rapidly into the jejunum, causing a feeling of distension after meals and diarrhœa. In the second condition there is an atonic stomach and the stoma has been made too high up, so that the food cannot escape when the patient is erect. The latter condition is avoided by making the stoma at the lowest part of the organ, and if already made both conditions are improved if the patient will lie down for half an hour after meals.

(6) JEJUNOSTOMY. This operation is seldom needed but is most useful in certain conditions. It consists in finding the highest part of the jejunum and making a valvular fistula into it round a rubber catheter as in Kader's gastrostomy. We have found this operation most useful in a case of duodenal fistula following subphrenic abscess and in cases of perforation of gastric ulcers where good closure of the ulcer was impracticable and yet immediate feeding of the debilitated patient was essential to maintain strength.

AFFECTIONS OF THE LIVER AND BILE-PASSAGES

INJURIES OF THE LIVER. This organ may be ruptured by blows or crushes or penetrated by perforating wounds of the abdominal wall with sharp or blunt instruments such as bullets. The extent of laceration varies greatly, from a slight tear with but little bleeding to pulping of the viscus, which may be burst into fragments, resulting in death in a few seconds.

Signs. Where the laceration is severe there will be symptoms of internal hæmorrhage, pallor, a small rapid pulse, syncope and air-hunger, while dullness of the right flank, increasing in amount, as well as local bruising, may point to the site of the lesion.

The diagnosis can seldom be made with absolute certainty short of opening the abdomen. Hence if the abdomen is rigid and tender and the pulse-rate rising, whether signs of bleeding be present or not laparotomy should be done, the surgeon being prepared to find rupture of the liver, spleen, some hollow viscus, or a combination of these.

Treatment. The less severe cases may be placed in bed and watched. Where signs are severe or becoming worse the abdomen is opened in the epigastrium, and if free blood be found the hand rapidly swept over the liver, spleen, and kidneys. If the liver be found ruptured the portal hilum should be grasped between a finger in the foramen of Winslow and the thumb, thus compressing the hepatic artery and portal vein and preventing further loss of blood.

Effused blood is quickly sponged away and the rent repaired with interrupted sutures of thick catgut inserted widely into the substance of the liver, or the wound in the latter is stuffed with gauze, the end of which is brought out of the abdominal wound and removed in thirty-six hours. The latter plan is the more generally useful : if sutures be employed they must be tightened very gently or they will tear through the friable liver.

INFLAMMATIONS OF THE LIVER. Diffuse, non-suppurative inflammations of this organ are described in works on internal medicine : the after-effects of diffuse hepatitis, viz. cirrhosis with ascites, are to some degree amenable to surgical measures, and these are mentioned in the section on Affections of the Peritoneum (p. 127).

SUPPURATION OF THE LIVER ; LIVER ABSCESS. Suppuration of the liver may originate as follows :

(1) Blood-borne infections, chiefly along the portal vein, which may be :

(a) Small multiple abscesses in the condition known as " portal pyæmia," in which acute infection spreads along the portal vein from appendicitis, sloughing hæmorrhoids, &c., the condition being beyond any surgical measures.

(b) Large abscesses, usually chronic in nature, consecutive to dysentery, often single, and known as *tropical abscesses*.

(c) In general pyæmia multiple abscesses may arise from infection *via* the hepatic artery.

(2) Infection spreading along the biliary passages and known as infective cholangitis is described amongst the affections of the bile passages.

(3) Suppuration in connection with hydatid cysts.

(4) Suppuration in blood-clot after injuries of the liver.

Liver abscesses which come under the notice of the surgeon are commonly large in size, usually single and of chronic nature, and secondary to hydatid or tropical dysentery, though abscesses of the liver may occur in the absence of either of these predisposing causes and be of an acute nature.

Anatomy. The pus of a tropical abscess may be yellow in colour, but is more often thick and of a brownish-red, resembling anchovy sauce. The wall of the abscess varies, being of ragged, disintegrated liver substance in the more acute forms, while there is much fibrous tissue in the chronic types, which may be of a toughness almost cartilaginous. The contents of these abscesses are often sterile, but the amœba of dysentery may be found, while in the more acute cases ordinary pyogenic cocci are present.

Signs. Tropical abscesses may be latent for years and suddenly burst, causing severe and possibly fatal peritonitis, or leak and cause a subphrenic abscess. More usually there is pain in the liver region with fever and enlargement of the organ. The fever is of the intermittent variety with sweats and rigors, and often suggests malaria, especially in the tropics, where liver-abscess is also common.

Of general signs, wasting, loss of appetite and strength, and a yellowish discoloration of the skin are noted.

On examination the liver is enlarged and tender, the enlargement being mostly upward so that the base of the right lung is compressed (these abscesses are most common in the right lobe of the liver, though we have come across a case in the left lobe of acute nature and simulating a left anterior, subphrenic abscess). The liver-dullness may rise as high as the angle of the scapula behind. The liver moves on respiration, so that the

lower margin of the swelling is not fixed as with subphrenic abscess ; rarely fluctuation of the abscess in the liver can be made out.

Besides rupturing into the peritoneum the abscess may burst into the pleura, causing empyema, or even be coughed up, passing through the lung.

Diagnosis. From malaria examination of the blood and failure to react to administration of quinine will readily distinguish. From intermittent hepatic fever due to diseases of the bile passages diagnosis may not be easy, but the jaundice is far more obvious in the latter condition and increases after each attack of fever. Leucocytosis is present, but the polymorphonuclears are only increased if the abscess is of pyogenic origin. The final diagnosis often rests on exploring with the hollow needle and syringe ; this should be done only when all is ready to continue the operation if necessary.

Treatment. Where the swelling presents in the abdomen the latter should be opened over the swelling, and if the liver be adherent to the parietes sinus-forceps may be thrust through, pus evacuated, and a large tube inserted. If the liver be not adherent it should be packed off with gauze and the abscess opened with sinus-forceps and all pus and sloughs carefully removed, the cavity swabbed out till quite dry, after which a tube is placed in the abscess cavity with a small piece of gauze round it to encourage formation of adhesions.

When the abscess is in the upper posterior part of the right lobe, diagnosis must be made on the operating table with the exploring needle in a similar manner to that employed in searching for subphrenic abscess. The needle is entered through the lower intercostal spaces and below the costal margin in the mid-axillary line, at the angle of the scapula, and in the right nipple-line. When pus is found a piece of the rib immediately below the needle-prick is removed and the diaphragm sewn to the parietal pleura in order to shut off the pleural cavity, the liver packed off with gauze from the peritoneal cavity, sinus-forceps thrust along the track of the needle, the abscess opened, evacuated, dried out, and a drainage-tube inserted as before—the gauze packing being left in twenty-four hours till adhesions are formed, which will prevent leakage of pus around the aperture in the liver.

HYDATIDS OR ECHINOCOCCUS DISEASE OF THE LIVER. The liver is the commonest part of the body for tænia echinococcus to take up its abode while in the asexual, cystic stage.

Anatomy. These cysts vary in size from that of a pea to a pumpkin, and are usually (1) filled with clear fluid and daughter-cysts of varying size, but (2) may contain fluid only or (3) be shrivelled with the contents inspissated, calcified, and mortary ; while (4) sometimes suppuration may occur.

The cysts consist of an outer fibrous sac formed by the irritated liver of the host. Inside this is the cellulose ectocyst (white and tough) of the parasite lined with the soft, granular endocyst or living part of the hydatid, inside which may be growing scolex-heads.

Signs. A painless enlargement of the liver of more or less globular outline appears without fever or jaundice, which may present in the epigastrium, particularly if the left lobe be affected ; more often where the right lobe is the seat of the disease the latter is enlarged upwards, compressing the base of the right lung. If left untreated such cysts may ultimately shrink up and become calcified or continue growing and burst into the peritoneum, causing peritonitis, or into the stomach, lung, pleura, or pericardium.

Diagnosis. A painless, spherical enlargement of the liver is to be distinguished from a gumma by the history and Wassermann reaction. The chronicity and absence of cachexia separates it from cancer of this organ. From hydronephrosis and enlarged gall-bladder the history and anatomical relations will help to distinguish. An eosinophilic leucocytosis is found in cases of hydatid disease fairly often and is suggestive. Diagnosis is often uncertain till exploratory laparotomy is performed, when on puncture of the cyst its perfectly clear contents of very low specific gravity and the presence of hooklets (microscopically) make the diagnosis obvious. Needling through the parietes should only be done with the same precautions as for abscess, viz. when ready to at once proceed with the radical operation. When large the fluid thrill or fluctuation may be felt.

Treatment. This consists in removing the cyst by operation ; puncturing is dangerous. According to its position the cyst may be approached from in front by the paramedial incision or from behind after resecting a portion of rib as for liver-abscess, with suturing of the diaphragm to the chest-wall. The swelling is packed round and the cyst tapped, which causes the ectocyst to collapse and separate from the fibrous tissue around ; the opening in the liver is enlarged and the cyst separated from its bed. The tough, white, cellulose ectocyst is gradually pulled out, bringing with it the endocyst and daughter-cysts ; after the whole cyst has been extracted the cavity is drained for a few days. Where suppuration has taken place the treatment is on the lines laid down for tropical abscess.

Cancer of the Liver. This is almost always secondary, the liver being filled with nodules of various size, usually of whitish-yellow colour ; sometimes, however, the neoplasm is distributed uniformly through the organ.

Signs. The liver can be felt enlarged, hard, and often nodular, and there are often ascites and jaundice, while cachexia is usually marked, though this is not invariable for some while. The condition is, of course, inoperable, but is important to recognize as evidence of the inoperability of the primary cancer to which it owes its origin, *e.g.* cancer of the stomach, rectum, breast, &c. ; and a careful examination of the liver will save useless operations in such conditions. Operative measures are only feasible where the tumour is primary and localized or where it spreads directly from the gall-bladder ; in such cases the tumour may be removed with a margin of liver-tissue, affording at least temporary relief.

Surgery of the Biliary Passages. *Anatomy.* The gall-bladder is a pear-shaped diverticulum of the common bile-duct, lying on the under-

surface of the liver opposite the ninth costal cartilage and separated from the falciform ligament by the inch of the quadrate lobe. Traced back to the cystic duct, the bladder narrows, but just before reaching the latter it usually expands into a well-marked pouch (Hartmann), which is a useful landmark in excision of the organ, showing where it ends. The gall-bladder is firmly fixed to the liver by its peritoneal covering except at the fundus, where a certain amount of movement is possible. The cystic duct joins at an acute angle the hepatic duct, formed of right and left branches coming
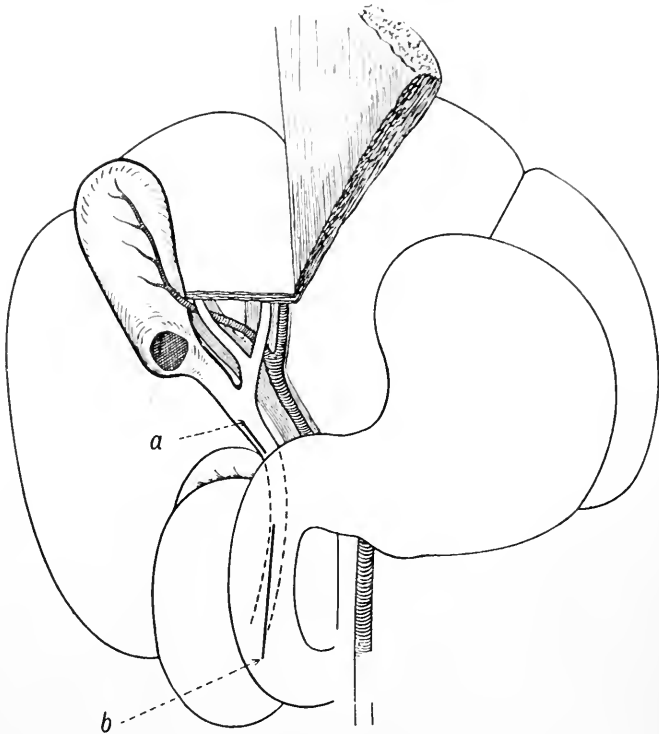
FIG. 57. Surgical anatomy of the biliary passages, the liver turned up. A stone is represented at the commencement of the cystic duct. *a*, Incision to open the common duct in its peritoneal part. *b*, Transduodenal route to reach the lower end of the common duct.

from the transverse fissure of the liver. The junction, or common duct, proceeds in the right free edge of the gastro-hepatic omentum, down behind the second part of the duodenum, opposite the middle of which it ends by piercing the posterior wall of the latter at the papilla of Vater, having first received the duct of Wirsung from the pancreas. In the gastro-hepatic omentum the common duct lies in front of the foramen of Winslow, where it has the hepatic artery on its left and the portal vein behind, *i.e.* the duct is on the extreme right edge of the gastro-hepatic omentum (a point to be remembered when the duct has to be opened). Further, the duct is covered extensively with peritoneum in its upper part, but, as it lies behind the second part of the duodenum, is entirely extra-peritoneal (Fig. 57).

A tumour formed by the gall-bladder, distended by blockage of a stone in the cystic duct or induration of the head of the pancreas (inflammatory or cancerous) pressing on the common duct, is noted as a rounded swelling projecting below the right lobe of the liver, with which it is continuous and which is mobile on respiration. This condition has to be distinguished from a lappet of the right lobe of the liver which comes down like a tongue to the right of the gall-bladder, often associated with gall-stones and caused by corset-pressure, known as Riedel's lobe. This is less rounded than a distended gall-bladder, but if there is abdominal rigidity the difference is not easy to make out.

A very large cystic swelling formed by a distended gall-bladder may closely resemble a right hydronephrosis, since both lie immediately below the liver. A tumour of the gall-bladder will, however, be dull in front, while a renal swelling has in front the resonance of the colon ; further, a renal tumour projects more into the loin and is less mobile on respiration. Omental and mesenteric cysts are separable from the liver and do not move on respiration.

EXPLORATION OF THE BILIARY PASSAGES. The patient is in the dorsal position, and a three-inch sand-bag or special bar attached to the operating-table is placed under the lower ribs. This has the effect of pushing the common duct some inches nearer the surface and rendering operations on this region more accessible.

The abdominal wall is opened by a paramedial incision through the right rectus rather further out than that used for exploring the stomach and duodenum ; if more room be needed, the second incision may be carried inward from the upper end of this through the rectus, in which case the epigastric vessels must be secured, and if the rectus be sutured carefully it will unite very well. The liver is pulled downwards and rotated up by the assistant to obtain a good view of the biliary passages (Fig. 31E, p. 92, vol. ii).

INJURIES OF THE BILIARY PASSAGES. Rupture of the gall-bladder or bile-ducts may take place inside or outside the peritoneum. The former is more common and occurs where the gall-bladder or upper part of the ducts above the duodenum are ruptured, the latter when rupture takes place behind the duodenum.

(1) *Intraperitoneal Rupture. Signs.* If the bile be sterile, after the initial shock the symptoms may be slight : some tenderness and rigidity of the upper abdomen and, later, signs of free fluid in the flanks and pelvis ; where the shock is severe the case may resemble one of intra-peritoneal bleeding. If the case be watched, absence of bile from the stools will be noted later. Where the bile is not sterile, as in cases of cholecystitis, there will be a rapid onset of peritonitis as after perforation of other hollow viscera, but normal bile may remain in the peritoneum for days or weeks without causing peritonitis.

Treatment is laparotomy, when the free bile in large amount will show the nature of the injury. The rent in the viscus must be sutured if possible, but if the lesion be in the gall-bladder and this is badly torn, excision of

the latter may be advisable. If the common duct cannot be sutured a gauze pack should be placed around and the bile allowed to drain off till adhesions form, when there is some chance of the passage becoming restored.

(2) Extraperitoneal (retroperitoneal) rupture may occur in the lower part of the common duct as it lies behind the second part of the duodenum. In a case of this sort, which we met with, the patient recovered rapidly after being run over the lower thorax, but in about three weeks the upper abdomen became swollen, the liver-dullness was increased, there was little tenderness or rigidity, and bile was present in the stools ; dullness of the base of the right lung was present, and the temperature was irregular but not above 100°. The signs suggested a subphrenic abscess, except that the patient's general condition was too good for this affection. On opening the abdomen a cystic swelling was found behind the lesser sac of the peritoneum and extending above the liver, and this proved to be filled with bile. After drainage of the collection for some weeks the condition cleared up with complete recovery.
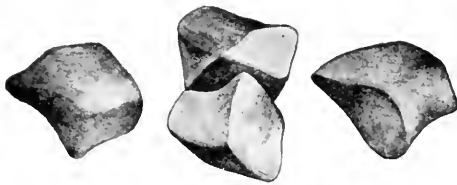
FIG. 58.   Gall-stones, faceted by mutual pressure on the gall-bladder.

GALL-STONES ; CHOLELITHIA-SIS. Biliary calculi, or gall-stones, are at once the result and the cause of inflammations in the biliary passages. They are the result of mild chronic inflammations, and by their presence as foreign bodies set up severe and dangerous inflammations.

Biliary calculi consist of cholesterin tinged with bile pigments, of bile pigments red or green and tolerably pure, or of bile pigments and cholesterin mixed with calcium salts. In form, size, and number they vary exceedingly. If single they are rounded or ovoid in shape and often of large size, being recorded up to three ounces and over (Fig. 59). When more numerous they are of the size of teeth to hazel-nuts, and are faceted by mutual pressure from contractions of the gall-bladder (Fig. 58). Smaller stones occur in hundreds and resemble shot in shape and colour. The larger stones are found in the gall-bladder, cystic and common ducts, are usually of cholesterin and generally crystalline, presenting a silky surface on fracture. The small stones resembling shot are very dark, and consist mostly of calcium and pigments. The gall-bladder may be stuffed with the latter or they may be found in any part of the biliary apparatus. The surface of the larger gall-stones is smooth, but the smaller sort are fairly often rough and spiky, especially if found in the ducts and not in the bladder.

Formation and Etiology of Gall-stones. Cholesterin, which plays so important a part in the formation of gall-stones, is not secreted by the liver but is formed in the bile passages, especially if these be the seat of mild catarrhal inflammation (Naunyn). This refers especially to the gall-bladder, for in the bile-ducts the stones are more often formed of calcium and pigments. Gall-stones are associated with the presence of micro-

organisms in the bile, especially the colon and typhoid bacilli, as well as the pneumococcus and staphylococcus, and their formation has been caused experimentally in rabbits by injection of cultures of attenuated organisms into the gall-bladder. Virulent organisms cause acute cholecystitis but fail to produce calculi.

It is uncertain whether the infection of the bile passages ascends from the duodenum or passes via the blood-stream ; modern views favour the latter hypothesis, and at autopsies patients suffering from gall-stones and gastric ulcers show lesions of the appendix more often than do the general run of cadavers, which suggests that the appendix is the primary source of infection in many instances.

To sum up, a chronic catarrh of the mucosa of the gall-bladder arises from infection with colon or enteric bacilli, probably due to blood-borne infections. This catarrh increases the amount of cholesterin in the bile : the colloids in the bile are increased by the inflammatory exudate, which renders the stronger solution of choles- terin still more likely to precipitate, and the presence of pieces of mucus, desquamated epithelium, or colonies of bacteria form a nuclei around which precipitation and crys- tallization readily occur. The importance of foreign bodies in forming nuclei for precipi- tation is shown by the formation of calculi around silk-threads introduced into the gall- bladder at operation or experimentally.

Fig. 59. Large single gall-stone, removed from the small intestine, where it was causing intestinal obstruction.

Another important factor is mechanical, viz. the stagnation of bile caused by enteroptosis, corsets, constipation, pregnancy, sedentary habits, &c., shown as follows : 75 per cent. of cases of gall-stones occur in women, and of these 90 per cent. have been pregnant ; 25 per cent. of women over sixty years of age have gall- stones.

Gall-stones occur at all ages but are rare under twenty-five, and 50 per cent. of cases occur over forty years of age.

Signs. (*a*) There may be none at all, the stones remaining quiescent in the gall-bladder till the patient dies of other causes.

(*b*) In a large number of instances the earliest sign is *dyspepsia, i.e.* pain coming on at some interval after meals, often waking the patient up at night, associated with much flatulence and sometimes retching, but not often with real vomiting. Nor does vomiting, when it takes place, relieve the pain as in cases of gastric ulcer. The pain tends to radiate to the right shoulder, and there may be tenderness over the gall-bladder. A test meal will usually show low acidity. The age and sex of the patient will help to discriminate this form of dyspepsia from that due to duodenal ulcer. Flatulent dyspepsia in middle-aged, obese women is often due to gall-stones, seldom to duodenal ulcer.

(c) *Biliary colic* is a paroxysmal pain of great severity associated with vomiting and sometimes, in the more severe instances, with collapse and syncope. There may in addition be fever and even rigors, though more than one of the latter suggests cholangitis (*see* p. 180). The pain radiates from the costal margin to the right shoulder.

(d) A *tumour* formed by the distended gall-bladder may be present if the stone lodges in the cystic duct, if the bladder is not shrunken by previous inflammation. Where the stone lodges in the common duct distension of the gall-bladder is rare, but another sign,

(e) *Jaundice*, will be present. This varies from the mildest yellow tinge, as when stones are passing readily down the duct, to deep orange verging on greenish black, when the stone has been firmly impacted in the duct for some weeks and the latter is thoroughly obstructed. At the same time the urine will show the presence of bile and this secretion will be absent from the fæces, which are then pale and fatty.

(f) Examination of the fæces, breaking up these in carbolic lotion, and passing through a sieve may show the presence of gall-stones.

(g) Intestinal obstruction may be the first sign of gall-stones. This does not result from stones passing down the normal ducts but from quiet ulceration of a large stone through the gall-bladder into the intestine, along which it passes till it becomes impacted at some narrow part, *e.g.* the ileocæcal valve (Fig. 59).

(h) In other instances the first sign of gall-stone trouble may be inflammation of the gall-bladder varying from mild suppuration to acute phlegmonous inflammation with perforation or gangrene, as shown by signs of acute peritonitis starting in the right upper quadrant of the abdomen.

Diagnosis. In the slighter manifestations this has to be made from the other dyspepsias. Where colic is present, from other varieties of colic, renal and intestinal. The radiation of the pain to the shoulder and not to the leg and genitalia will distinguish from the former, while absence of any indiscretion of diet or signs of lead-poisoning will help to separate the latter : jaundice and alterations of the urine and fæces will be of further help.

Tenderness of the gall-bladder is another valuable sign which may be well brought out by making the patient sit up and placing a hand firmly under the right costal margin. The patient is then asked to take a deep breath ; where there is inflammation of the gall-bladder the patient will wince and catch the breath as the gall-bladder comes down on to the examining hand (Murphy).

RESULTS OF GALL-STONES. As has been already mentioned, biliary calculi may remain quiescent in the gall-bladder, causing no trouble, or they may occasion disease of the bladder or start on their travels along the bile passages, causing various troubles as they go. These affections are due either to a blocking of the passages traversed by the gall-stones or to irritative and infective conditions set up by their presence, and these often occur in conjunction, as the damming-up of the biliary outflow forms

a convenient nidus for the growth of infective organisms. The sequelæ of gall-stones arise in the gall-bladder, the cystic duct, the common duct, or the intestine.

(1) In the *gall-bladder* the irritation of the stones sets up inflammation of the wall of the viscus, which may be catarrhal, phlegmonous, gangrenous or fibrosing, according to the severity of the associated infection : these affections are described under Cholecystitis.

(2) When the stone reaches the *cystic duct* it causes, during its passage, colic, but not jaundice. If the stone cannot pass the cystic duct, the latter becomes blocked and the mucus secreted by the gall-bladder accumulates behind and dilatation of the bladder results. This condition is known as " mucocœle " of the gall-bladder (hydrops vesicæ fellæ). Such dilatation of the gall-bladder may reach huge proportions, being then likely to be mistaken for hydronephrosis or an ovarian cyst. But not infrequently the resulting tumour is smaller than the normal gall-bladder owing to the previous shrinking of the gall-bladder as the result of past inflammation.

The mucus which collects in the distended bladder readily becomes infected and suppuration may result, the contents being then pus mingled with mucus, and there is a varying degree of inflammation of the gall-bladder wall ; this condition is known as " empyema " of the gall-bladder. Such a blocking of the cystic duct is one of the commonest causes of acute inflammation of the gall-bladder. Should the inflammation be more acute, gangrene or perforation may result, while in other instances the infection is milder and may subside without operation but leaving adhesions about the gall-bladder which fix it to surrounding structures, together with contraction of the bladder, both of which are very characteristic of the old-standing calculous gall-bladder.

(3) In *the common duct* the passage of a stone causes colic and slight jaundice, which becomes greater if the stone is definitely impacted. It is a notable fact that in these cases the gall-bladder is very seldom dilated (Courvoisier's law) ; the explanation commonly given is that the gall-bladder is shrunken up by previous attacks of inflammation and cannot dilate even though the calculus be firmly stuck in the common duct. In such a case the patient will suffer from attacks of severe colic associated with deepening jaundice, the gall-bladder being but seldom enlarged ; if the bile be infective the bile passages will undergo inflammation or cholangitis, which is recognized clinically by intermittent fever with rigors, the " intermittent hepatic fever " of Charcot.

Signs of Calculous Obstruction of Biliary Ducts. (a) Where the cystic duct is obstructed there will usually be a history of biliary colic or dyspepsia for some months or years, and transient jaundice may have occurred. The onset is tolerably acute, with pain in the hepatic region and often some fever. On examination there will be found a tumour having the characters of a distended gall-bladder, but its appearance is often masked by rigidity of the abdominal muscles over it, for in most instances

the condition is not a pure mucocœle but inflammation is present as well. The signs of acute cholecystitis are discussed later and may follow in the train of a mucocœle.

(*b*) Impaction of stone in the common duct is seldom found except with a long history of attacks of gall-stone colic associated with jaundice.

In the present attack the jaundice persists and becomes more and more deep with each attack of colic. The gall-bladder is seldom enlarged, which serves to distinguish this affection from blocking of the common duct due to induration of the head of the pancreas (inflammatory or cancerous), which also causes deepening jaundice but with great distension of the gall-bladder (Courvoisier) ; while in addition there is fever, which is unusual in cancer of the head of the pancreas, and the liver is seldom enlarged as happens in cancer of the organ, another cause of deepening jaundice.

(4) Ulceration of the gall-bladder or the ducts may lead to perforation into the peritoneum and peritonitis. More often the fistula will lead into some other viscus, generally the duodenum, at times the stomach, while occasionally it may point on the surface, usually at the umbilicus. In this manner gall-stones may escape into the intestine and, from becoming impacted in some narrow part, cause intestinal obstruction.

(5) Cancer of the gall-bladder is likely to develop from the irritation produced by gall-stones, and this possibility is of importance in the treatment of affections of this viscus.

TREATMENT OF GALL-STONES. Where the signs are uncertain and mild, as in the dyspeptic type, medical measures may be tried, viz. attention to diet, light meals in the evening, and keeping the bowels open with saline aperients. If such measures prove of no avail exploration is advisable after a few months, as the diagnosis is often uncertain and the trouble may be due to disease of the stomach, duodenum or appendix, for which also operative measures are needed.

For the colic, morphia in repeated doses of a quarter of a grain should be given ; a whiff of chloroform is the quickest means of relieving the agony while the morphia is being absorbed. Where infrequent attacks of colic are the only signs medical measures should be persevered with for some months, as there is always a chance that but few stones, and they small, are present and may be safely passed. Surgical intervention is indicated under the following conditions :

(1) For persistence of symptoms, whether dyspepsia or colic, after a fair trial has been made of medical measures, whether jaundice occurs or not.

(2) For persistent jaundice with colic, whether the gall-bladder is enlarged or not, remembering that in the former condition a calculus in the common duct is unlikely, in the latter most probable.

(3) For distension of the gall-bladder without jaundice, as in such cases there is usually a stone impacted in the cystic duct.

(4) In cases of acute peritonitis of the right upper quadrant of the abdomen suggesting severe inflammation of the gall-bladder, such as

empyema or gangrene, though similar signs may be present from perforation of gastric or duodenal ulcer or pancreatitis, in which case also operation is urgent.

(5) For fistula connected with the bladder or the ducts.

(6) For intestinal obstruction.

The operation advisable will be discussed in the section on Operations on the Gall-bladder.

INFLAMMATIONS OF THE BILIARY PASSAGES

These include *cholecystitis*, or inflammation of the bladder, and *cholangitis*, or inflammation of the ducts.

CHOLECYSTITIS. This may be acute or chronic, with or without blocking of the cystic duct, though in most instances of the acute inflammations a blocking of the cystic duct with a calculus is the most important predisposing cause. Apart from calculi, infections spreading from the intestinal tract, such as appendicitis and enteric fever, are important causes, and these are likely to cause mild infections tending to production of calculi. Where stones are not found inside the inflamed bladder they may have been passed.

Inflammation of the gall-bladder may terminate in different ways. The more acute varieties may set up diffuse peritonitis by spreading through the wall of the organ or by perforation, or gangrene of the whole viscus may supervene, in which case it will resemble an over-ripe fig, being purple, black, swollen, and œdematous. Empyema may develop in the less severe types of infection, or ulceration with perforation into other viscera or on the surface, with escape of gall-stones, pus and bile, as has been mentioned. In still more chronic and fibrosing forms the bladder becomes thickened and converted into fibrous tissue, the lumen being partly obliterated till the organ is not much larger than a lead-pencil ; such shrunken gall-bladders are surrounded by dense adhesions, evidence of past peritonitis.

Finally, cancer not infrequently supervenes on such chronic inflammatory processes.

Signs. These have been for the most part mentioned. The more acute types present signs of peritonitis in the upper abdomen on the right, viz. rigidity, tenderness, pyrexia, rigors, vomiting, and perhaps collapse, varying with the severity of the lesion. In the less urgent empyema, there is found a distended gall-bladder with fever, and perhaps tenderness and some rigidity of the abdominal wall. The shrunken gall-bladder is commonly found in operations on cases of cholelithiasis of old standing.

Treatment will be considered in the section on Operations on the Bile Passages, but two operations require attention :

(*a*) Draining the gall-bladder, cholecystostomy.

(*b*) Removing the gall-bladder, cholecystectomy.

Removal of the gall-bladder is indicated in cases where inflammation is very acute and the organ is gangrenous or likely to become so soon, on the usual principle of removing a highly infective focus from the abdomen. On the other hand, a greatly shrunken gall-bladder is also best removed

on account of the probability of its becoming cancerous, while it is of little value to serve as a drain-channel for the biliary passages.

Where the infection of the bladder is fairly mild and it is not greatly inflamed it may suffice to drain its cavity, hoping that it will return to its normal condition, and should it later take up the rôle of a gall-stone factory it may then be removed. Where there is any reason to doubt the present or future patency of the common bile-duct (*e.g.* for stones in the common duct) the gall-bladder should only be drained, as it serves as a very convenient safety-valve to conduct the bile to the surface or into the intestine (cholecystenterostomy).

CHOLANGITIS. Two forms of this affection are described, the less passing into the more grave condition. These are infective and suppurative cholangitis.

(1) *Infective Cholangitis* (intermittent hepatic fever). This is essentially due to an incomplete block of the common duct near its lower end. The biliary passages with the exception of the gall-bladder dilate behind the obstruction, which is seldom enlarged. This condition may last for years without suppuration in the ducts taking place.

Signs. There are repeated attacks of gall-stone colic with rigors and jaundice (Charcot's intermittent hepatic fever); the jaundice deepens after each attack of colic. The spleen may be enlarged but the health between the attacks may be good. It will be noted that this condition is practically the same as that described under Impaction of a Stone in the Common Duct.

Treatment. Removal of the stone and drainage of the bile passages through the gall-bladder.

(2) *Suppurative Cholangitis.* In this condition there are suppuration and ulceration of the distended bile-ducts extending into the liver and sometimes empyema of the gall-bladder as well. The usual cause is blockage by a stone in the common bile-duct, but hydatids or cancer of the biliary passages and enteric fever account for some examples.

Signs. These are similar to those in infective cholangitis, viz. colic, rigors and deepening jaundice, but in addition the liver becomes enlarged and there is progressive wasting and weakness. The prognosis is very grave even after a stone has been removed from the common bile-duct and the biliary passages drained.

TUMOURS OF THE GALL-BLADDER. The viscus may be distended by bile, mucus, pus, or stones in the conditions which have been already described. In addition the gall-bladder may be the seat of new growths, of which cancer is the common form.

CANCER OF THE GALL-BLADDER. This disease is usually secondary to gall-stones, and is found in the chronically inflamed bladders associated with cholelithiasis of long standing. The wall becomes thickened and ulcerated and the invading epithelial cells spread to the liver and peritoneum. When a large number of shrunken fibrous gall-bladders are examined it is found that a quite appreciable number present early changes of a malignant

nature, showing the wisdom of removing these useless organs even when to the naked eye there may be no indication of malignancy. Where the growth has assumed the size of a tumour, palpable from outside the abdomen, the probability of its being removable is but small, though cases are recorded where a cancerous gall-bladder and surrounding liver have been removed with success.

TUMOURS OF THE BILE-DUCTS. The common duct may become distended and form a large cystic tumour resembling in character those of the gall-bladder. The cause is a partial block of the lower end of the duct by a stone or a growth (cancer) of the papilla of Vater. Such cases are very rare, and present the physical signs of deepening jaundice with a cystic tumour below the liver, practically indistinguishable from a dilated gall-bladder unless the latter can be felt as a small tumour perched on the top of the greatly distended duct, which may, as we have seen, attain the size of a football.

Treatment. The condition may be relieved by establishing a fistula between the distended bile-duct and the surface (choledochostomy), but attempts to cure the affection by anastomosing the dilated common duct with the intestine have not been successful at present. Of course, if due to a stone in the papilla of Vater, the obstruction should be removed through the duodenum.

CANCER OF THE COMMON BILE-DUCT. This commences in the papilla of Vater and blocks the common duct. The signs are increasing jaundice with a distended gall-bladder, often followed by suppurative cholangitis, as shown by intermittent fever, rigors, swelling of the liver, wasting, and weakness—in fact, very much the signs found in cancer of the head of the pancreas, which indeed often appears to originate in the lower bile-duct.

Treatment. The growth should be removed if possible, but such an attempt is likely to prove a very extensive operation involving resection of part of the duodenum. In most instances all that can be done is to divert the bile through the gall-bladder to the surface or into the intestine (cholecystenterostomy).

OPERATIONS ON THE BILE PASSAGES

These concern the gall-bladder and common duct, which may be opened for removal of stones or for drainage, or anastomosed to the intestine, while in addition the gall-bladder may be excised.

(1) CHOLECYSTOSTOMY, OR DRAINAGE OF THE GALL-BLADDER. This is the simplest and most generally useful operation, since it provides a way for removing stones from the most usually affected part of the biliary apparatus and also of draining this system where this is advisable. The following indications are given :

(1) After removal of gall-stones where the bladder is large enough to be drained readily and not so diseased as to be unlikely to recover.

(2) For infective and suppurative cholangitis.

(3) Where the common duct has to be opened, to avoid tension on the sutures there.

(4) For mucocœles and empyemas of the gall-bladder where the wall is not severely affected. In our opinion most cases of this nature will be treated more satisfactorily by excision of the bladder.

In doubtful cases it is generally safe to drain, for if the bladder does not become normal and continues to form calculi it may be removed later, and cancer is more prone to occur in the shrunken form, which is unsuitable for drainage.

Operation. The incision for exposing the biliary apparatus has already been described. In chronic cases there will often be many adhesions to be unravelled before the gall-bladder is found. When distended by a mucocœle or empyema the gall-bladder is found at once as a tense cyst.

When well exposed the bladder is packed off with sponges or gauze-packs from the stomach, duodenum, colon and right kidney-pouch, and then emptied of pus or bile with trochar and cannula, to avoid soiling the surroundings with what may be highly infective material. The gall-bladder is opened by a small incision and the calculi removed with scoop or forceps and its interior explored with scoop or fingers, palpating along outside the duct till satisfied that no stones remain and that the passage is clear, as shown by passing a flexible probe down along the common duct into the duodenum. If the stones are in the common duct and cannot be " milked " back into the bladder they are removed by *choledochotomy (see later)*. In rare instances it may be right to close the bladder without drainage, but only if the interior is absolutely normal and the gall-stone attacks are quite recent. As a rule, if the bladder be not excised it should be drained. A rubber tube of one-quarter of an inch bore is fixed into the aperture in the gall-bladder with a purse-string suture, and the gall-bladder is fixed to the posterior sheath of the rectus and peritoneum close to the aperture with a couple of sutures ; the packing is removed and the posterior and anterior sheaths closed as usual. As the mucosa of the bladder is some distance from the skin there is no danger of a permanent fistula arising.

The tube may be left in for ten days, and after its removal the bilious fistula will close in two to three weeks if the common duct be pervious. Should the fistula persist for several weeks, and especially if no bile appear in the stools, it may be inferred that there is some block in the common duct, and further operation should be done to investigate the cause and put matters right. In cases where the gall-bladder is too shrunken and yet it is decided to drain (for cholangitis or block of the common duct where the patient is too ill to stand further operation), the peritoneum is stripped off the posterior abdominal wall and sutured down to the gall-bladder round the drainage-tube in the form of a conical invagination.

(2) CHOLEDOCHOSTOMY ; DRAINAGE OF THE COMMON DUCT. This operation is performed, on the lines of the previous one, for cystic dilatation of the common duct.

(3) CHOLECYSTECTOMY, OR EXCISION OF THE GALL-BLADDER. *Indications* :

(*a*) Injuries where suture is impracticable.

(*b*) In the more severe and acute inflammations, phlegmonous, gangrenous, empyema, &c., where the cystic duct is blocked and there is good reason to believe that the common duct is pervious.

(*c*) For mucocœle in most instances.

(*d*) For shrunken, fibrous bladders difficult to drain and likely to become cancerous.

(*e*) For actual cancer.

Briefly, the gall-bladder is best removed in all cases where it is severely diseased and likely to be a further seat of gall-stones or is dangerous from the severity of the infection or likely to become cancerous, always provided that the common duct is not obstructed and that cholangitis is not present.

Operation. This is as before, up to the separation of adhesions and exploration of the bladder and ducts, though in acute phlegmonous inflammation we have found it good practice to remove the bladder unopened. The dissection is begun most easily at the fundus, dividing its peritoneal attachments to the liver, from which the bladder is separated by blunt dissection till the cystic duct is reached, which is recognized by the bulge of the bladder (Hartmann's pouch) just before this point is attained. The cystic duct is tied with the cystic artery and the organ removed. Care is needed in dissecting backwards to avoid tying the common and hepatic ducts, for to include these in the ligature will prove disastrous. The raw surface of the under-side of the liver may be covered by suturing the peritoneum over it ; this is only feasible in chronic cases, and if not possible makes little difference. A drain-tube is left in under the liver for twenty-four hours and the wound closed ; this is an excellent operation and most satisfactory in its after-results.

(4) CHOLEDOCHOTOMY ; OPENING THE COMMON BILE-DUCT. Where stones in the common or cystic duct cannot be milked back into the gall-bladder and so removed or squeezed through the papilla of Vater into the duodenum, they are removed by incising the duct over them. In the case, however, of stones in the cystic duct it will as a rule be best to remove the gall-bladder if the common duct be patent, since the resulting stenosis of the cystic duct will lead to retention of the contents of the gall-bladder and mucocœle, empyema, &c. Choledochotomy, therefore, is reserved for removing stones from the common duct.

Stones may be impacted :

(*a*) Above the duodenum, where the duct lies in the edge of the lesser omentum.

(*b*) In the part of the duct behind the duodenum.

(*c*) In the wall of the duodenum, *i.e.* in the papilla of Vater.

Operation. The preliminary part is as before, opening the gall-bladder and exploring the ducts, locating the stone in the common duct by sounding from within and palpating outside.

(a) Where the stone is in the duct above the duodenum a finger in the foramen of Winslow will hook the duct nearer the surface, and the latter is incised longitudinally over the stone, keeping to the right or free edge of the lesser omentum, well away from the portal vein and hepatic artery. The stone is extracted, the rush of bile sponged away, and the interior of the duct further investigated with probe or finger if much dilated : other stones may be found and removed. The duct is then closed with interrupted sutures of absorbable catgut. Drainage should be employed after this operation through the gall-bladder for ten days if the cystic duct be patent, while in addition a tube should be placed down to the common duct for three days in case leakage takes place. If the gall-bladder will not serve as a drainage channel a tube may be fixed into the common duct with a purse-string suture and left in ten days, after which time there will be enough adhesions to prevent dissemination of bile into the peritoneum.

(b) Where the stone is behind the duodenum it is best, if possible, to shift it into the part of the duct higher up and remove as before ; if the duct be much dilated it will be worth opening the latter above the duodenum and trying to extract the stone with scoop or forceps from above.

When such measures fail it is, on the whole, safer to attack the duct through the duodenum, passing through both walls (after occluding its lumen above and below with intestinal clamps) and suturing after removal.

The alternative is to incise the peritoneum to the right of the duodenum and cut through the pancreas till the stone is reached, which may cause severe hæmorrhage.

(c) Where the stone is in the papilla of Vater the duodenum should be opened and the orifice of the papilla slit up, rendering the removal of the stone easy ; the duct is probed and the duodenum sutured.

(5) CHOLECYSTENTEROSTOMY. Operations for anastomosing the biliary passages with the alimentary canal are only occasionally needed, since in most instances the cause of obstruction is a stone in the common duct, and this should be removed.

Indications. (a) Stenosis of the common duct, which occasionally arises as a sequel to ulceration caused by impaction of stones in this region.

(b) Stenosis is due to pressure from outside the common duct when due to chronic fibrosing pancreatitis. It is doubtful if this operation is justifiable in stenosis of the bile-duct due to cancer of the head of the pancreas, as the mortality is about 50 per cent. (Robson).

(c) Biliary fistulæ in some instances.

The anastomosis should be made into the duodenum or stomach, and is done with sutures as described for intestinal anastomosis. If this appear too difficult a small Murphy button may be employed.

(6) CHOLEDOCHENTEROSTOMY. Anastomosis of the common duct with the stomach or duodenum. This may be done when the duct is much dilated and cystic and the blockage of the duct is irremediable, especially where the gall-bladder is shrunken and useless for purposes of drainage or

the cystic duct is stenosed ; the operation is also done by suturing (lateral anastomosis).

For *biliary fistulæ*, where the blockage of the common duct is not removable and the discharge is bile, either of the above operations should be performed as is most safe and convenient ; but where the discharge of the fistula is only mucus the gall-bladder should be excised if operation seems necessary to the well-being of the patient.

AFFECTIONS OF THE PANCREAS

It will be remembered that the pancreas performs at least two functions : the proper glandular acini secrete a digestive fluid which passes into the intestine along the duct of Wirsung, which joins the lower end of the common bile-duct. This fluid has the power of digesting proteids, carbohydrates, and fats. In addition the organ contains groups of cells known as the Islands of Langerhans, which have no duct but produce an internal secretion of importance in the general metabolism, and especially of carbohydrates, since destruction of these produces glycosuria. Hence affections of the pancreas may produce effects on the digestive or metabolic functions.

Anatomy. The pancreas lies with its head in the curve of the duodenum, its body extending across the bile-duct, vena cava, portal vein, and aorta in front of the first and second lumbar vertebræ, while its left extremity, or tail, is in relation with the left kidney and spleen ; in front the pancreas is in relation with the lesser sac of the peritoneum, the stomach, and meso-colon.

The pancreas is palpable in thin subjects, and when enlarged or cystic is found as a tumour in the epigastrium which does not move on respiration and lies behind the stomach, *i.e.* there is resonance in front of it unless very large, when it pushes past the stomach and comes to the front.

EXPLORATION OF THE PANCREAS. This is possible from in front or behind.

(1) The viscus may be reached in front by a paramedial incision through the upper rectus on either side. When inside the abdomen there are three possible routes : (*a*) above the stomach, through the lesser omentum ; (*b*) below the stomach, through the gastro-colic ligament ; (*c*) below the transverse colon, through the transverse mesocolon. A small hole is made, avoiding vessels, and this is enlarged by blunt dissection. The route to take depends on the position of the stomach and colon ; if they are prolapsed the route above the stomach may be taken, but if these organs are well up in the abdomen the gastro-colic ligament should be divided. The route through the mesocolon, though the easiest, should be avoided where drainage is likely to be needed, as the lower route is more likely to lead to spread of infection to the coils of small intestine below, while the route suggested ensures the presence of that useful protector the great omentum between the path of drainage and the tender guts.

(2) The posterior route is by a loin incision below the last rib, similar to that used for exposing the kidney ; after dividing the muscles a blunt

dissection is made in the retroperitoneal tissues. This method has the merit of being extraperitoneal, but only allows access to the head or tail of the organ, and therefore is more likely to be useful as a secondary operation to secure drainage than to explore the pancreas.

INJURIES OF THE PANCREAS. The pancreas may be injured by crushes or penetrating wounds. In severe injuries other organs will almost certainly be implicated and death occur rapidly from hæmorrhage and shock. In less severe lesions there is still much danger, because the fluid escaping from an injured pancreas erodes surrounding tissues and causes further destruction of the organ with hæmorrhage and peritonitis. The escape of pancreatic juice causes characteristic changes in the tissues where it escapes, as is well seen in the peritoneum. The resulting changes are known as "fat necrosis," and appear as patches, varying in size, of a yellowish-white colour and smooth, shiny surface. The tissues affected are necrotic, losing their staining reactions (as observed with the microscope), and the white patches are formed of a combination of the fatty acids, set free by the pancreatic ferments, with lime salts. The broken-down and digested material of the partly disorganized pancreas may remain confined to the lesser sac of the peritoneum and be walled off by adhesions, forming a "pseudo-cyst of the pancreas." Apart from laparotomy diagnosis is hardly possible. In an exploration for severe abdominal injury the presence of fat necroses shows the nature of the lesion, though these are also found in rupture of the duodenum. It is important not to miss lacerations of the pancreas, since these lead to peritonitis of a severe nature.

Treatment. The laceration should be repaired if possible by suturing with catgut, and the site covered with peritoneum or omentum. Drainage is always advisable to afford exit to the dangerous exudate from the pancreas, and this should be made for choice through the gastro-colic ligament.

INFLAMMATIONS OF THE PANCREAS; PANCREATITIS. These affections may be divided into acute and chronic, of which the extreme types present very different clinical pictures; but there occur a whole series of cases of subacute nature which, in our own experience, has proved the most common type and presents signs intermediate between the extreme types.

(1) *Acute Pancreatitis, Pancreatic Apoplexy, Hæmorrhagic Pancreatitis, and Gangrene of the Pancreas.* This uncommon and often fatal disease is notable for the acuteness of the lesion in many instances, the œdema being gross and often accompanied by extravasation of blood; clinically, by presenting the appearance of a very grave abdominal lesion of the peritonitic variety; pathologically, as being an inflammation the cause of which is not perfectly understood but which fairly often seems not to be due to infection with micro-organisms, an unusual condition for so acute an inflammation.

Anatomy. The pancreas is huge, engorged, œdematous, red or purple, and often sloughy or gangrenous. Hæmorrhages and areas of fat necrosis are found scattered through the organ. The intestines are distended and the peritoneum inflamed and showing fat necroses, while the exudate is

blood-stained and often copious. In some instances stones obstructing the common duct are found and bile is present in the pancreatic ducts.

Pathology. The ferments in the normal pancreas are inactive and require " sensitizing " by some other organic fluid in order to become capable of hydrolizing proteid, fat, or carbohydrate. This sensitizing or activating does not usually take place till the pancreatic juice reaches the small intestine, when, to put the matter in physiological terms, the inactive trypsinogen is converted into active trypsin by the entero-kinase of the succus entericus. Other organic materials (including blood and bile) besides succus entericus have this activating power ; hence a hæmorrhage into the pancreas will cause a production of active trypsin from its harmless precursor and the organ will be digested, its vessels eroded, and the process spread further with hæmorrhage and auto-digestion. In a similar manner, bile escaping into the pancreas along the duct of Wirsung, owing to blockage of the common bile-duct with a stone or being injected experimentally, activates the trypsinogen and digests the organ, causing spreading and hæmorrhagic inflammation. It is doubtful if infection plays any part in the matter till later, when suppuration and gangrene occur. Probably the origin in many instances is pancreatic apoplexy, *i.e.* hæmorrhage from some of the pancreatic blood-vessels, which give way in persons whose vessels are degenerate, and this is rendered more probable from the fact that the affection usually occurs in middle-aged, obese, alcoholic persons, whose blood-vessels are certainly degenerate. Regurgitation of bile into the duct of Wirsung accounts for some cases and injuries perhaps for others, while infection may account for a few cases. The hæmatemesis which is sometimes found as well as the intraperitoneal bleeding is supposed to be due to the glycerine set free in formation of fat necroses, and has been produced experimentally by injection of glycerine.

Signs. The onset is sudden and severe in a middle-aged person, usually of the male sex and of fatty habit and alcoholic history. There is severe abdominal pain starting in the epigastrium, vomiting, sometimes hæmate-mesis, and great prostration and collapse, the temperature being subnormal in the most severe types but raised in the less acute varieties. The abdomen rapidly becomes distended and tympanitic, constipation is marked, some-times a vague tumour is felt in the epigastrium caused by the distended pancreas. The condition rapidly passes from bad to worse ; the face assumes the Hippocratic characteristics and death takes place in two to five days. Occasionally the symptoms abate and the patient recovers and may suffer from further attacks, which eventually prove fatal.

Diagnosis. This can seldom be made with accuracy but may often be shrewdly suspected. The conditions likely to be confused with pancreatitis are severe phlegmonous inflammations of the gall-bladder and stomach or acute intestinal obstruction, especially volvulus ; and as these conditions also demand immediate laparotomy, exact diagnosis matters little in practice. The important matter is to recognize that the condition is that of ' acute abdomen."

(2) *Subacute Pancreatitis.* This condition comes on suddenly but with less severity and prostration than the hæmorrhagic type. There is epigastric pain, pyrexia, and often distension of the gall-bladder, and possibly jaundice. On exploration the pancreas is enlarged to two or three times its size and is œdematous, but hæmorrhages are not present or of minor degree and fat necroses absent for the most part. This condition forms a connecting-link between the acute hæmorrhagic and the chronic varieties.

(3) *Pancreatic Abscess.* Suppuration in the pancreas may follow minor degrees of the hæmorrhagic inflammation by infection of necrotic areas or by primary infection of the pancreas *via* the biliary and pancreatic ducts, being then often a sequel to calculi. The inflammation is less fulminating and more localized, breaking down into pus in and around the organ.

Signs. These are similar to those of the acute variety but less urgent, viz. epigastric pain, vomiting, fever, and a tender tumour in the epigastrium. Constipation or fatty diarrhœa, glycosuria, and jaundice may be sometimes found in these cases, as in the subacute type mentioned above, while fat necroses are uncommon.

Treatment. Laparotomy will be undertaken for a severe abdominal lesion. The presence of blood-stained fluid in the abdomen and fat necroses in the more urgent cases will point to the seat of disease ; in the less acute cases the boggy swelling of the pancreas and distension of the gall-bladder will be noted.

In the hæmorrhagic form the huge œdematous pancreas is exposed by opening through the gastro-colic ligament, softened areas are incised along the course of the duct—*i.e.* horizontally—packed with gauze and a tube inserted, to control bleeding and act as a drain ; the exudate is sponged away from the abdominal cavity and the pelvis drained. Necrotic areas of pancreas should be removed and any abscess should be opened, swabbed out and drained, always passing the drain-tube above the great omentum. The bile passages should be examined, and if the gall-bladder be distended it should be opened and quickly examined for stones, and if any found they are removed and the bladder drained. It is questionable whether posterior drainage through the loin is worth the increased length of the operation, as the amount of pancreas exposed is small.

After-treatment consists in the Fowler position, administering saline per rectum or through the appendix, which may be brought to the surface (*see* Appendicostomy), and opening the bowels with calomel and turpentine enemata.

In the subacute form, where the gall-bladder is distended, this should certainly be drained, of course exploring for gall-stones ; the pancreas may be left alone in the less severe forms, but if very œdematous there is no harm in draining it as before. The outlook for this type is good, though the pancreatitis may become more fibrous, and then it will be necessary to anastomose the gall-bladder with the duodenum or stomach, as in the chronic form.

The prognosis of the hæmorrhagic type is poor, though with early

operation, careful drainage, and treatment of shock a certain number recover.

(4) *Chronic Pancreatitis.* In this affection there is an interstitial fibrosis of the pancreas, due presumably to mild infection *via* the ducts, which in turn is set up by biliary and pancreatic calculi, duodenal inflammation, enteric fever, &c., and may develop in sequence to subacute pancreatitis.

Anatomy. The pancreas is larger and feels hard, the head being especially affected. Microscopically an important distinction is to be made between the cases where the islands of Langerhans are affected (causing glycosuria) and where the latter escape.

Signs. These may be grouped from the effect of the fibrosis on various parts :

(a) Deepening jaundice and distension of the gall-bladder, due to pressure on the common bile-duct, associated with pain resembling gall-stone colic but less severe, and referred to left rather than the right shoulder ; pale stools ; bile in the urine.

(b) Results of damage to the ferment-secreting acini, fatty stools, dyspepsia, and wasting.

(c) Affection of the islands of Langerhans, causing glycosuria and wasting. Fever is sometimes present.

Diagnosis has to be made from gall-stones impacted in the common duct and cancer of the head of the pancreas. From the former affection diagnosis may be difficult, especially as pancreatitis may be a sequel to gall-stones : a few suggestive points are :

(a) The gall-bladder is seldom enlarged when the jaundice is caused by a stone in the common duct (Courvoisier).

(b) Fatty diarrhœa, wasting, and enlargement of the pancreas are not found in gall-stone cases.

(c) The pain is less in pancreatitis and not referred to the right shoulder.

(d) There may be glycosuria in pancreatitis.

Diagnosis from cancer of the head of the pancreas is more important, since while operation is advisable in both pancreatitis and gall-stones, it is best avoided for cancer of the pancreas.

In cancer, the later time of life at which the affection commences, the more rapid wasting, and invariable presence of a dilated gall-bladder with jaundice are suggestive ; but it must be confessed that even when the abdomen has been opened the difficulties of diagnosis are often great.

Treatment. Operation with a view of draining the biliary and pancreatic ducts is always indicated, since not only is the obstruction to the flow of bile and the consequent jaundice obviated, but the drainage may enable the pancreas to recover and perform its functions.

Operation. The abdomen is opened through the upper part of the right rectus as in exploring the bile passages ; these and the pancreas are investigated, and any gall-stones present are removed. The question is whether the gall-bladder should be drained on the surface or into the alimentary tract. Drainage on the surface is advisable where there is definite infection

of the bile passages and calculi or where the pancreatitis is approaching the subacute type, since this may allow the inflammation of the pancreatic and biliary passages to subside and the bile again to flow through the papilla of Vater : where there are no calculi it will be best to anastomose the gall-bladder with the duodenum or stomach at once, for if a fistula be established on the surface, the subsequent anastomosis, should the latter prove necessary, will be more difficult. The results are good for some time unless the islands of Langerhans are destroyed, when the patient gradually wastes away.

CALCULI OF THE PANCREAS. These are infrequent but cause important changes in the pancreas, and consist of carbonate of lime and phosphate of magnesia.

The results of calculi are : (*a*) Inflammation, usually chronic in character but sometimes acute, as described above. (*b*) Blocking of the duct of Wirsung and formation of cysts. (*c*) The irritation of calculi may cause the growth of cancer in the organ.

Pancreatic calculi seldom attain any great size but may be very numerous.

Signs and Diagnosis. Epigastric pain of a severe character, which may be described as colic, referred to the mid-line or left ; dyspepsia ; fatty stools. The appearance of stones in the fæces of different appearance to gall-stones and more opaque to X-rays may help to distinguish from the latter with which the affection is most likely to be mistaken in the earlier stages. The later results, pancreatitis and cysts, are described elsewhere. Pancreatic calculi are usually found by the surgeon when exploring in obscure cases of pancreatitis and pancreatic cysts.

Treatment. At present in most instances the calculi have been removed from the lower part of the duct of Wirsung, approached through the duodenum and opening the papilla of Vater. In other instances the duct has been opened in its length, approaching it through the gastro-colic ligament and incising the pancreas. Finally, the duct has been brought to the surface and drained by dislocating the tail of the organ, bringing it up through the mesocolon and suturing to the abdominal wall. This last measure may be of use when stones are very numerous and any pancreatitis is present.

CYSTS OF THE PANCREAS. These usually occur in the middle-aged, though they have been recorded in infants and are due to several causes. Simple blocking of the duct is insufficient to cause formation of a cyst, some alteration of the epithelium being also necessary. Injuries play a tolerably important part in their formation. Cysts due to injuries and inflammation may be grouped together, since the latter often follows the former and is to some extent the determining cause of traumatic cysts. The other main varieties are those due to new growth and calculi. Following the classification of Körte, the following varieties are described :

(*a*) *Cysts due to Trauma and Pancreatitis.* Some of these are blood-cysts and are essentially due to localized acute pancreatitis of relatively benign type. In this group, and indeed forming a large part of it, are

the pseudo-cysts due to effusion of pancreatic exudate into the lesser sac of the peritoneum, which contains pancreatic ferments and the wall of which is formed in part by the pancreas : this group includes nearly one-third of the cases.

(b) Cysts due to chronic fibrosing inflammation and blocking of the ducts or to blocking of the latter with calculi, which may be the cause of the chronic pancreatitis. The duct of Wirsung may be the seat of a series of small dilatations throughout its length resembling a " rosary," or the cyst may be larger and spherical. Stenosis of the duct may also arise from scarring (calculous) or cancer. Chronic pancreatitis will also cause formation of smaller cysts from blocking of tributary ducts or acini. This group includes nearly one-half of the cases.

(c) Cysts of new growth arise in cysto-adenomas or carcinomas of the gland, and may contain polypoid, intracystic growths. This group contains about one-third of the cases.

(d) Congenital cystic disease is a rare cause of cysts.

(e) Finally the ubiquitous hydatid is added to complete the list.

Signs. Of general signs there may be little noted, or a history of dyspepsia, attacks of colic and vomiting (calculi). Fatty diarrhœa and glycosuria are uncommon and jaundice is rare, while emaciation only occurs late except in cancerous conditions. Locally a cystic swelling of varying size will be found in the epigastrium, not moving on respiration and fixed to the posterior wall of the abdomen. This swelling lies behind the stomach and colon, but when increasing pushes these aside and comes to the surface in front between these organs, but may be found above the stomach or below the transverse colon. Should the cyst be in the tail of the organ the swelling will be noted to commence on the left of the middle line.

The fluid contents of these cysts is albuminous, has a specific gravity of 1010 to 1020, and is usually dark brown in colour, but may be blood-stained, clear, green, black, or milky, and is alkaline in reaction. Ferments are usually present, but the only one of real significance is proteid-splitting or tryptic ferment.

Diagnosis. The median position and immobility distinguish from a distended gall-bladder. From hydronephrosis the median position away from the loin and investigation of the ureters, the urine from each ureter differing in hydronephrosis, while injecting the ureters with collargol and taking a radiograph will be of help in a difficult case. From omental and mesenteric cysts the diagnosis may be impossible if the latter have become fixed. As, however, laparotomy is the treatment in either condition, exact diagnosis is less important.

Treatment. Excision of the cyst is seldom possible, but has been successful in some instances where the swelling was small. Incision and drainage give very good results. The abdomen having been opened, the cyst is packed off from the general peritoneal cavity and punctured with a trochar, where it comes to the surface (usually through the gastro-colic ligament) ; then the last-mentioned structure is further divided and the

edges of the aperture thus formed in the cyst sewn to the posterior sheath of the rectus and a drainage-tube inserted, which is gradually shortened as the cyst contracts. Where the cyst is large it may be advisable to make a counter-opening in the left loin and drain through the latter, closing the original incision. Healing is slow but the prognosis is good, the mortality being only 5 per cent. Recurrence after drainage sometimes takes place.

NEW GROWTHS OF THE PANCREAS. Adenomas, sarcomas, &c., are recorded but are extremely rare ; the only neoplasm demanding consideration here is cancer.

This usually commences in the head of the gland.

Signs. Rapid weakness and wasting, associated with deepening jaundice and dilatation of the gall-bladder, form a fairly characteristic picture when occurring in persons of past middle age. Fatty diarrhœa and glycosuria are not common. Later the tumour may involve the pylorus and give rise to dilatation of the stomach or press on the vena cava and cause œdema of the legs and ascites.

Treatment. Removal by excision is seldom possible. Palliation of the jaundice by cholecystenterostomy is so fatal as not to be advised where the diagnosis is certain, but the results of this plan of draining the gall-bladder are so good in cases of chronic pancreatitis that where the diagnosis is not certain the patient may be given the benefit (if benefit it be) of the doubt.

SURGERY OF THE SPLEEN

Anatomy. The spleen is situated in the upper posterior part of the abdomen on the left side ; it comes as far forward as the mid-axillary line, lies under the ninth, tenth, and eleventh ribs, and is about the size of the palm of the hand. It is in relation above and behind to the diaphragm ; below and in front to the stomach, kidney, pancreas, and colon.

Examination. The spleen is not normally palpable, but when enlarged it may be felt coming out below the left costal margin, moving freely on respiration, lying close under the abdominal wall so that it feels superficial ; the anterior and lower edge is sharp, and along this border one or more notches may be felt. Lying as it does against the anterior abdominal wall, the spleen gives an area dull on percussion, and the dullness extends over the lower ribs up and backward.

INJURIES OF THE SPLEEN. The spleen may be ruptured by crushes and blows, especially if enlarged by malaria, the result being intraperitoneal hæmorrhage of varying severity.

Signs and Diagnosis. The signs after such an injury are suggestive of internal hæmorrhage, and attention is directed to the spleen by finding shifting dullness in the left flank and perhaps local bruising. The rigidity, tenderness and even tympanites may suggest rupture of a hollow viscus.

Treatment. Laparotomy should be prompt if the condition be grave, and as the diagnosis is seldom certain the incision should be near the middle line (paramedial) in the upper abdomen, and the liver, spleen and kidneys

examined as previously detailed. If the spleen be found ruptured a gut-clamp should be placed on the pedicle to control bleeding and effused blood sponged away; the spleen is then brought up to the surface and further examined. If the anterior incision does not admit of ready access to the spleen a transverse incision to the costal margin through rectus and obliques should be made from the lower end of the longitudinal incision. It may be found possible to suture the wound in the spleen, but in most instances where the bleeding is sufficiently severe to render laparotomy advisable the spleen will be found too badly ruptured for conservative measures and must be excised. The pedicle is secured with interlocking ligatures and divided near the spleen to avoid wounding the tail of the pancreas, or divided between clamps, taking care not to divide any part of the pedicle before tying or clamping, or troublesome bleeding is apt to take place.

FLOATING OR WANDERING SPLEEN. In this affection the pedicle is over-long, the organ prolapsing into the iliac fossa, and it has even been found in an inguinal hernia.

The condition is usually found in women with enteroptosis, but also occurs apart from this. The organ is generally enlarged, but whether this is the cause or result of prolapse is uncertain. Owing to the length and narrowness of the pedicle the latter is likely to become twisted, causing congestion, inflammation with adhesions or even gangrene of the organ.

Signs. Dragging pain and a tumour in the left loin brings the patient up for advice, and it is then found that the tumour has the characters of the spleen, its superficiality, smooth surface, sharp edge and notch being unmistakable, while the mobility is excessive unless fixed by adhesions, when diagnosis may be more difficult. Where torsion has recently occurred the signs are those of acute peritonitis with a large tumour, the condition being then very like that found in cases of twisted ovarian cyst.

Treatment. When causing discomfort the organ should be fixed by operation after a trial has been made to relieve the condition with a well-fitting belt. Two methods have been used : (1) The organ is exposed and gauze packed round it, the latter being left for a week to cause adhesions to form; after the gauze is removed the patient is kept supine in bed with the feet elevated for three weeks to cause the spleen to slide into its proper place by force of gravity and become adherent.

(2) The other plan is to make an extraperitoneal bed for the organ below the ribs, separating the peritoneum from the transversalis muscle. The spleen is pushed into this pocket and the mouth of the latter secured round the pedicle of the spleen with sutures. Sutures should not be passed through the spleen, as it is too friable and likely to bleed severely.

The second method seems more commendable, as the introduction of gauze tampons for so many days is likely to cause intestinal obstruction.

For acute torsion, laparotomy and removal of the organ are indicated.

SUPPURATION AND ABSCESS OF THE SPLEEN. This may follow injury or arise in the course of some general infection, the process being embolism and breaking down of the infarct.

Signs. The spleen becomes enlarged and tender and later fixed, the signs then being those of suppuration in the left hypochondrium (perisplenic abscess) with general signs of infection—pyrexia, rigors, wasting albuminuria, &c.

Treatment. The spleen may be explored below or through the lower ribs on the left side (*see* Subphrenic Abscess), the surrounding peritoneum packed off if not already fixed by adhesions, and the abscess opened. Where the spleen is free and converted into a bag of pus it should be removed by incision in the linea semilunaris or by a flap method, described under Splenectomy.

ENLARGEMENT OF THE SPLEEN. This is due to many causes, most of which are outside the scope of surgery, including malaria, syphilis, kala-azar, leukæmia, Hodgkin's disease, rickets, lardaceous disease, cirrhosis of the liver.

Removal of the spleen is contra-indicated in all the above conditions, with the possible exception of malaria in certain cases. The mortality is 25 per cent. ; still, as the malarial spleen is rather a dangerous possession for its owner (from liability to rupture), its removal may sometimes be advisable, and of late several cases have been reported of good results following excision of a ruptured malarial spleen.

There remain three forms of splenic enlargement where excision is good treatment, viz. splenic anæmia, cysts including hydatids, and new growths.

SPLENIC ANÆMIA. This is also described as splenomegaly and Banti's disease, and seems to be a definite affection, separable from the enlarged spleen secondary to cirrhosis of the liver, which presents some similarity.

The signs are :

(1) Enlargement of the spleen, which may be great.

(2) Severe anæmia of the chlorotic type (according to some writers the anæmia is of the secondary type). Pigmentation of the skin and hæmatemesis may be noted.

(3) Later ascites and jaundice develop.

The disease occurs usually in young females, and is apt to be fatal in from three months to as many years.

The pathology is obscure ; it is probably a chronic infective process associated with increased hæmolysis in the spleen.

Diagnosis is made from leukæmia and Hodgkin's disease by absence of the characteristic leucocytosis of leukæmia and the absence of enlargement of the lymphatic glands in the latter condition.

The chronicity will help to distinguish from new growths.

Treatment. Excellent results have been obtained by excision of the spleen in this condition, the blood-count rising to normal and the general state greatly improving in a few weeks.

New growths of the spleen are usually fibro-cystic or sarcomatous. These conditions are rare, and may be suspected when the spleen rapidly enlarges without any signs of malaria, leukæmia, &c.

Splenectomy is the correct treatment, and if done sufficiently early will be successful.

EXCISION OF THE SPLEEN ; SPLENECTOMY. This can be done for trauma through the left paramedial incision or the same enlarged by cutting transversely to the left as described. Where the spleen is very large it will be better to make a special incision as follows :

The anterior sheath of the rectus is split to the left of the middle line nearly as far as the umbilicus ; a second incision is carried out from the lower end of this, splitting the external oblique along its fibres ; the rectus is divided transversely at the lower part of the longitudinal incision and reflected out with the anterior layer of the sheath and the external oblique ; the internal oblique and transversalis are then divided horizontally, starting from the middle of the longitudinal incision and cutting to the left. This gives free access and does little harm to the innervation of the abdominal muscles. The pedicle of the spleen is secured with the precautions described for excision of a ruptured spleen, carefully securing all parts before dividing. The abdominal wall is sutured in layers.

CHAPTER XXI

AFFECTIONS OF THE INTESTINES, INCLUDING INTESTINAL OBSTRUCTION

Congenital Defects of the Intestine : Injuries of the Intestine : Foreign
Bodies in the Intestine : Inflammations of the Intestine : Simple Perforating
Ulcer : Typhoid Ulceration : Tuberculous Ulceration : Dysenteric Ulceration :
Ulceration from Foreign Bodies : Stercoral Ulceration : Stenosis and Dilatation
of the Intestine : Affections of Diverticula : The Appendix : Acute Appen-
dicitis : Results of Appendicitis : Chronic Appendicitis : Types : Treatment
of Appendicitis : Complications of Appendicitis : Diverticulitis : Affections
of Meckel's Diverticulum : New Growths of the Intestine and Rectum : Spread
of Cancer : Treatment of Cancer : Indications for Various Operations : Ex-
cision of Cancer of the Large Intestine : Rectal Cancer : Excision of the
Rectum for Cancer.
Intestinal Obstruction : General Considerations : Ætiology : Varieties : Acute
Mechanical Obstruction : Clinical Aspects : Snaring of Intestine, Varieties :
Acute Kinking : Volvulus : Intussusception : Impaction of Foreign Bodies :
Mesenteric Thrombosis : Ileus developing in the course of Chronic Obstruction :
Examination and Treatment of Intestinal Obstruction : Special Varieties :
Resection of Bowel for Gangrene : Chronic and Partial Obstruction of the
Intestine : Varieties : Diagnosis : Treatment : Intestinal Stasis : Operations on
the Intestines, Colostomy, and Enterostomy.

SURGERY of the intestines is concerned with congenital defects, injuries,
inflammations and growths, as well as the great clinical group of cases known
as intestinal obstruction which forms the latter half of the present chapter,
which depends for its causation on the conditions about to be described.

CONGENITAL DEFECTS OF THE INTESTINE

(1) Congenital narrowing (stenosis) of the intestine is found in various
parts :

(*a*) In the duodenum at the situation of the biliary papilla.

(*b*) At the lower end of the small intestine, in the situation of Meckel's
diverticulum.

(*c*) At the lower end of the large intestine, where the hind gut joins the
proctodæum, the intestine may be stenosed, either slightly or so completely
as entirely to occlude its lumen.

(2) DIVERTICULA. The only one which is at all common is known as
Meckel's, and represents the unobliterated, omphalo-mesenteric duct of the
foetus ; this is found within three feet of the ileo-cæcal valve opening into
the ileum.

The stenoses may be the cause of intestinal obstruction of varying
severity, while the diverticula may also cause this trouble or be the seat
of inflammation like other diverticula (*see* Affection of Diverticula).

INJURIES OF THE INTESTINE (*see also* Abdominal Injuries)

The intestine may be injured by penetrating wounds, such as stabs or bullet-wounds, or non-penetrating injuries, such as blows and crushes, and vary in severity with the degree of violence, fullness of the intestine, &c.

Non-penetrating wounds vary in degree from slight bruising of the intestinal wall, which readily recovers, to severe crushing, causing perforation or death of the wall of the gut or sufficient damage to allow of invasion of organisms, followed by perforation and diffuse peritonitis or local abscess. In some instances the mesentery is torn away from the intestine or the vessels are so injured as to thrombose, in which case the intestine supplied by the injured vessels is in imminent danger of becoming gangrenous.

Rupture of the intestine occurs chiefly in crush accidents or from being run over. The small intestine is most easily burst by being crushed against the bodies of the vertebræ, and gives way in the regions where it is fixed and cannot readily slide away, viz. at the upper end of the jejunum, the lower end of the ileum, and the junction of the first and second part of the duodenum. The large intestine, by reason of its mobility, is seldom ruptured ; the rectum is the part of the large gut most often thus affected, associated with fractured pelvis or impalement accidents, as where the patient sits on a spike.

Gunshot injuries will produce perforations anywhere in large or small intestine, which are often multiple.

Signs. (1) Pain, tenderness, and rigidity will be found over the damaged part, whether perforation or only bruising has taken place.

(2) Dullness round the site of injury points to perforation and extravasation or internal bleeding.

(3) Escape of fæcal or bilious material where there is a perforating wound is characteristic.

(4) The escape of the injured viscus through the abdominal wall may show the kind of lesion present.

(5) The escape of blood per rectum or small intestine through the latter orifice, as in a case where a child sat on the pointed leg of an upturned chair, which penetrated the rectum.

(6) Vomiting is often absent till the terminal vomiting of well-developed peritonitis sets in, but may be present where mere bruising has occurred.

(7) Free gas in the peritoneum, as evidenced by loss of the liver-dullness, while the abdomen is still retracted, will occasionally be noted.

(8) Shock varies greatly according to the amount and virulence of the extravasated material ; thus if the gut be empty there may be little shock for some hours. We have seen a child with the duodenum torn half across able to walk twenty-four hours after the accident. The pulse-rate should always be carefully watched, for it steadily rises in perforative lesions but tends to quiet down if bruising alone has occurred.

Diagnosis. The question to be settled is whether the abdomen should be opened, since if this be the case the sooner it is done the better. Surgical

intervention is needed not only where perforation has taken place, but is of almost equal necessity where bruising is severe or the mesentery badly torn. For if the vitality of the intestine be much impaired it will readily slough in a few days with disastrous results, while resection before perforation has taken place is almost certainly successful. The patient should be placed in bed and watched, no morphia being given to mask the signs. Attention is directed to the pulse, rigidity of the abdomen, local dullness of the latter, and general appearance of the patient. If the condition becomes worse an hour after the patient has been made comfortable with hot bottles, &c., the abdomen should be opened. Where there is free gas in the peritoneum, much free fluid, or such leading signs as protrusion of a viscus, escape of fæces from a wound, &c., the abdomen should be opened at once. In fact where the surgeon is not absolutely convinced by a consideration of all signs that the damage to the viscera is trifling the abdomen should be explored, since early operation is the salvation of patients suffering from severe lesions of the intestines, while a blank laparotomy, though mortifying to the surgeon's diagnostic sensibility, does the patient but little harm.

Treatment. The importance of early operation has already been urged. The abdomen should be opened by a paramedial incision with its centre at the umbilicus. The character of the fluid found, viz. blood, intestinal content or both, will give a clue to the type of injury and help to trace it to its source. Where there is only hæmorrhage this may alone need attention.

Small perforations may be closed with two rows of sutures as detailed before. Where the rupture is gross it may be better to excise the damaged part and restore the lumen by an end-to-end anastomosis. Where there is much bruising, and especially if the gut be torn away from the mesentery, the segment of gut affected should be excised as a precautionary measure : considerable judgment is necessary as to how much to do. In all cases, but especially in gunshot injuries, search should be made for more than one lesion, and where there is much bleeding the liver, spleen, and kidneys should be examined as well. Any hole torn in the mesentery or omentum should be carefully closed, or a loop of intestine may prolapse and become strangulated.

Drainage is indicated in most instances where there has been extravasation of fæces ; if the latter be extensive, after sponging away all that can be managed a tube should be placed in the pelvis through a stab-incision above the pubis, but if small and localized a local drain may be inserted for a couple of days.

FOREIGN BODIES IN THE INTESTINE. Several types of foreign body are found whose origin is due to many causes, as follows :

(1) *Substances Swallowed.* (*a*) Massive objects such as coins, clasp-knives, forks, &c., swallowed by children, professionals and lunatics, which may be retained in the gut.

(*b*) Substances swallowed in small quantities which tend to become felted together into masses (enteroliths), such as hair, the insoluble parts of oatmeal, certain drugs, especially carbonate of magnesia, are examples of this

kind ; while sometimes concretions of fæces form round small bodies such as pins or seeds, though the latter are more often suspected than proved.

(2) Concretions formed in the alimentary canal and its adnexa, such as gall-stones passing down the common duct or, if large, by ulceration through the wall of the gall-bladder into the intestine ; pancreatic calculi.

Fæcal concretions occur in diverticula of the intestine, especially the appendix, but also in Meckel's and in acquired diverticula ; also in the main channel of the intestine where there is stasis of the contents.

(3) Objects inserted by the surgeon form another group, some being left on purpose, as Murphy buttons, others inadvertently, as sponges, swabs, &c.

The results of foreign bodies in the intestine are :

(1) Intestinal obstruction if the object be large enough to block the lumen of the gut, *e.g.* gall-stones, Murphy buttons, large intestinal concretions, &c.

(2) Irritation and ulceration of the portion of intestine where the object lies, leading to suppuration, perforations, and finally to the development of cancer. These results will be considered under Diseases of the Appendix, Meckel's Diverticulum, Diverticulitis, &c.

Diagnosis is seldom possible unless the consequences mentioned ensue, viz. obstruction, ulceration, and perforation. Where a body of any size or of rough exterior has been swallowed it should be traced if possible with X-rays and removed by laparotomy if it remains fixed at any point. The pylorus, neighbourhood of the ileo-cæcal valve and the anal canal are the places where foreign bodies tend to lodge. The treatment of intestinal obstruction and of perforation are considered elsewhere (p. 247).

INFLAMMATIONS OF THE INTESTINE. The milder and more diffuse inflammations come under the hands of physicians ; the more severe and localized forms leading to ulceration, perforation, stenosis, &c., alone needing surgical treatment. Diffuse inflammations of the intestine or enteritis are usually due to irritants inside the intestine, but may also spread from the peritoneal surface inwards as in cases of severe peritonitis and grave lesions to the nerve and blood-supply of the intestine, as after strangulation of a loop of intestine in a hernia or under a band ; such enteritis is a serious complication of the cases and is evidenced by diarrhœa, sometimes blood-stained.

In practice this enteritis is treated with castor-oil followed by opium, while saline infusions are administered as there is often much collapse ; the prognosis in these cases is grave.

ULCERATION OF THE INTESTINE. This may affect the small or large bowel, and is due to various causes which fall into three main groups :

(a) Infective ulcers, including simple perforating ulcer, enteric, tuberculous, and dysenteric ulceration.

(b) Ulceration due to the irritation of foreign bodies together with infection, including hard objects swallowed, but the most usual cause in this group is a fæcal mass which often accumulates above a chronic obstruction of the bowel, the ulcer then being described as " stercoral."

(c) *Ulceration of Malignant Growths* (*see* Cancer of the Intestine, p. 220).

Like inflammations, most ulcerative conditions are in the, hands of

physicians, and as a rule only come to the surgeon for complications such as perforation or stenosis resulting from the ulcer, for conditions of chronicity and overgrowth (e.g. hyperplastic colitis), or for improving the means of using local lavage to the surface of the ulcers (e.g. appendicostomy for ulcerative colitis).

(1) *Simple Perforating Ulcer.* These occur in the upper jejunum, probably due to acute infection and necrosis of a lymphoid follicle. Such conditions very likely are common and without signs unless the ulceration passes deeper and perforation takes place. They are not unlike acute gastric ulcers, and when perforated cause similar signs. We have met with two such cases which were cured—in one instance by suturing, the other, where the ulcers were multiple, by excision of the portion of intestine affected and anastomosis. In operating on a case of acute perforative peritonitis it is well to bear this condition in mind, and if an ulcer cannot be found in the stomach or duodenum, to examine the upper jejunum as well.

Osler describes similar ulcers in the large intestine. Peptic jejunal ulcers have been already described.

(2) *Typhoid Ulceration.* Surgical treatment is only needed where perforation occurs, which may be an early or late complication but mostly takes place about the third week and in the more severe types of the disease, though perforation may be the first sign which brings the patient up for advice in the milder " ambulatory form " of enteric fever.

The result of perforation is invariably spreading peritonitis and death, hence early diagnosis and operative treatment are vital : the poor results resulting are partly owing to waiting to ensure absolute diagnosis and allowing the moment favourable to operation to slip by.

Signs and Diagnosis. (a) In cases where enteric fever is well developed and probably diagnosed. There is sudden pain in the right iliac fossa, increased rapidity of pulse, tenderness, rigidity, and later dullness in the right iliac fossa, usually a sudden fall in temperature and possibly irritability of the bladder. These signs indicate urgent need for laparotomy, and the surgeon will be unwise to wait for tympanites and the Hippocratic facies to develop, or the favourable opportunity will be gone for ever. Hæmorrhage from an ulcer is the condition most likely to be confused with perforation, as here also there will be pain and fall of temperature with rising pulse-rate, but there is no tenderness, dullness, or resistance in the iliac fossa, while pallor and deeper respiration will point to the real diagnosis.

(b) In the " ambulatory type " of enteric the signs are similar, and coming on in a patient apparently in good health will suggest appendicitis. Further investigation will show that the patient has really been indisposed for some days, and on examination the spleen will often be palpable, a few rose spots will be noted on the abdomen, and some moist sounds heard over the base of the lung. The diagnosis is of less importance where the surgeon habitually operates for appendicitis at once ; in fact, the occurrence of such cases is a further argument in favour of early operation in cases of peritonitis of the right iliac fossa.

Treatment. Under local or intraspinal anæsthesia the abdomen is opened by the paramedial incision below the umbilicus, displacing the right rectus outwards. The cæcum is drawn up and the lower part of the ileum examined. Perforated ulcers should be occluded with a through-and-through suture and then invaginated with interrupted sutures inserted at right angles to the axis of the bowel, to diminish the amount of stenosis thus caused. Multiple perforations must be looked for, and ulcers on the point of perforation also invaginated with sutures. Where a large part of the lower ileum is in a soft, rotten state it may be wrapped round with omentum or brought out on the surface and drained, but the outlook is well-nigh hopeless, and excision of the affected part is seldom advisable in patients already so depressed.

(3) *Tuberculous Ulceration.* This is found in the large or small intestine, the ulcers being characterized by their chronicity and induration, by the presence of miliary tubercles on the peritoneal coat, and by the ulcers tending to extend around the circumference of the gut, while typhoid ulcers spread along its length.

The complications of these ulcers are perforation and stenosis of the intestine causing obstruction, as well as tuberculous peritonitis and its sequelæ. Perforation is unusual owing to the proliferation of the peritoneum lying over the ulcer and the formation of adhesions, so that when leaking takes place a localized abscess more usually results than diffuse peritonitis. The treatment of such abscess is on the lines laid down for localized peritonitis, viz. opening and draining.

The outlook is poor, as such ulcers are often multiple and frequently associated with tuberculous peritonitis of the ulcerative type.

Occasionally these ulcers may be exposed at laparotomy and excised with the lymphatics and enlarged caseating glands ; we have found this give very satisfactory results, but it is not easy to decide on operation sufficiently early to admit of such complete removal.

Healing of the ulcers, owing to their transverse arrangement, is very prone to lead to annular stenosis of the intestine (*see* Intestinal Obstruction). Where the stenosis and matting of intestine by adhesions is localized it may be possible to obviate the obstruction by lateral anastomosis, or even to excise the affected part if not too extensive. The above refers to the small intestine : in the large bowel the process is somewhat different ; there is more chronicity and proliferation of fibrous tissue around the ulcer, spreading widely through the intestine, the result being the formation of a tumour of the large intestine resembling in appearance a diffuse, malignant growth which is known as *hyperplastic tuberculous pericolitis* or, as it often occurs in the cæcal region, " tuberculous cæcal tumour." In this condition the ulceration is minimal, the surrounding fibrosis being the notable feature. The wall of the intestine is thickened, firm and nodular, on section hard and fibrous, containing caseous foci ; and the glands along the colon (paracolic) may be enlarged, especially in young subjects (in some instances we have found that these form the greater part of the tumour).

Signs. These may be unnoticeable till intestinal obstruction supervenes or the tumour is felt, but there may be a history of alternating diarrhœa and constipation, hectic fever and wasting. The diagnosis lies between this condition and cancer, while if in the cæcal region the more chronic forms of appendicitis with adhesions present similar signs. The age is less than that at which cancer is common, *i.e.* under forty, and the duration, without great wasting, longer, viz. two to three years ; while the greater chronicity and better marked tumour will, as a rule, distinguish from a chronic appendicitis. These cases are, however, often wrongly diagnosed even at operation, and only discovered after microscopical examination of the supposed growth has been made.

Treatment. If possible the mass should be excised and the ends of the intestine closed, the lumen being restored by lateral anastomosis. Where removal is impossible owing to massive adhesions, size of the growth, or bad condition of the patient, the diseased part of the intestine should be short-circuited by anastomosing the intestine above with that below; this will relieve obstruction and diminish irritation from the fæces, giving some hope of healing. Excision is far superior where possible, and it is unnecessary to remove the main glands unless obviously breaking down ; nor need the excision be nearly so extensive as that indicated for cancerous growths.

(4) *Dysenteric Ulceration.* This affects the large intestine and is caused by infection with various bacteria, including Shiga's bacillus and the amœba of dysentery. The surgical complications are perforation, causing peritonitis, and liver-abscess, both of which have been sufficiently described.

Surgical assistance is required by the physician in the more rebellious cases to assist in making arrangements for more thoroughly washing out the colon, and this is best managed by performing appendicostomy.

Appendicostomy. Operation. The appendix is approached by the usual muscle-splitting incision and brought up to the surface, so that the cæcum is immediately under the abdominal wall. The appendix is then fixed with a couple of sutures, the parietes are closed, and the end of the appendix cut off. After two or three days a catheter is inserted along its lumen and the colon irrigated through this with normal saline, dilute silver nitrate 1 in 10,000, &c. The results are often excellent, but the small fistula should be maintained for several months, perhaps as long as a year, after recovery seems complete, as recurrences may arise and need further irrigation.

(5) *Ulceration caused by Foreign Bodies.* (*a*) The possibility of such objects as clasp-knives, forks, &c., ulcerating and causing perforation has been mentioned : the obvious indication is removal at the earliest opportunity.

(*b*) *Stercoral Ulcers.* Solid concretions of fæces tend to cause ulceration whenever they remain for some time in one position, and such ulcers often form when concretions are lodged in a diverticulum of the intestine, whether the appendix, a Meckel's diverticulum, or an acquired diverticulum. The term stercoral ulcer is, however, more usually applied to this form of ulceration occurring in the main intestine, where fæces cannot pass owing to chronic obstruction, and most usually happens in the cæcum, where there

is not only irritation caused by the concretions but distension of the intestine, so that perforation is likely to take place. This will cause spreading peritonitis or localized abscess according to the rapidity of diffusion of fæculent material, and is a very serious complication of chronic intestinal obstruction and an argument in favour of early operation.

STENOSIS AND DILATATION OF THE INTESTINE. These conditions are often found together, the dilatation being secondary to and occurring above the stenosis.

(1) Stenosis may be simple or due to malignant growths. Simple stenosis often follows ulceration, especially of tuberculous origin, owing to the manner these ulcers have of passing transversely round the intestine. Stenosis also follows ulceration occurring at the site of pressure in a loop of gut strangulated in a hernia or under a band. In the large intestine dysenteric and syphilitic ulceration may sometimes lead to stenosis. The possibility of stenosis following an end-to-end anastomosis has been mentioned already. Finally, pressure, from without, by tumours or inflammations of the peritoneum or the cellular tissue of the pelvis, followed by fibrosis, may lead to narrowing. The consequences of stenosis are increasing difficulty in the passage of intestinal contents, which is more pronounced in the large than the small intestine owing to the more fluid nature of the contents in the latter, the final result being intestinal obstruction, under which heading the matter is considered in detail.

Dilatation of the Intestine. This may be acute or chronic in nature and often secondary to stenosis, but may be primary, with no block below as in the paralytic form found in peritonitis. Dilatation of the intestine or *tympanites* and *ileus,* as the condition is sometimes called, are also considered under Intestinal Obstruction.

AFFECTIONS OF THE INTESTINAL DIVERTICULA. Diverticula of the intestine occur normally (appendix), as congenital abnormalities (Meckel's diverticulum) or as acquired abnormalities (diverticula of the large intestine).

In whatever way produced, these diverticula form blind alleys in which fæcal concretions can lodge, and are liable to become inflamed ; sometimes perforation results, in other instances fibrosing hyperplasia and occasionally cancer.

In addition the longer diverticula (appendix, Meckel's diverticulum) may act as snares or bands, causing intestinal obstruction.

AFFECTIONS OF THE APPENDIX VERMIFORMIS. *Anatomy.* The appendix is a diverticulum of the cæcum situated about one inch from the ileo-cæcal junction, at the point where the longitudinal muscular tæniæ of the cæcum come together. It is attached to the cæcum by its mesentery, the meso-appendix, containing its artery of supply, a branch of the ileo-colic which passes behind the cæcum. In length the appendix varies greatly, being longer in youth and diminishing with age ; from two to five inches are common variations and in rare cases it is absent, being represented by a solid tag formed by the convergence of the above-mentioned muscular tæniæ.

The position varies considerably ; it is found :

(*a*) Hanging down in the pelvis.

(*b*) To the left of the cæcum and amongst the small intestines.

(*c*) Below and behind the cæcum in one of the subcæcal pouches (this position is common in diseased conditions, though less so in ordinary persons, and may be of importance in the ætiology).

(*d*) To the outer side of the cæcum.

As regards structure the appendix contains much lymphoid tissue in its submucosa, and to such a degree that it has often been compared with the tonsil. There seems no reason to believe that this small diverticulum is more than a relic of the cæcum of our herbivorous ancestors, and to assume a definite function for this vestigial relic and regard it as an independent organ like the liver or pancreas is to take a very one-sided view ; one might as reasonably assume a different rôle to every individual square inch of the intestinal mucosa. Removal of this relic appears to make no difference to the metabolism of patients thus deprived : the originally useful cæcum has degenerated into a standing menace to the peritoneum.

Ætiology. The commonness of appendicitis is to some extent explained by the following points :

(*a*) Its rudimentary, or rather retrograde, nature, which has already been mentioned.

(*b*) The appendix is long and with a relatively narrow pedicle and only one artery of supply, which explains the ease with which its circulation is obstructed by twists or kinks, leading to inflammation, gangrene, &c.

(*c*) The lumen being narrow, it easily allows of lodgment of concretions, threadworms, &c., which in turn set up inflammation, ulceration, and so forth.

(*d*) Infection is the all-important factor, especially when assisted by the above-mentioned predisposing causes. This may occur without any obvious twist, kink or foreign body, and is found to have a relation to certain general infections, especially influenza : the disease may be more or less epidemic, affecting several members in one house.

(*e*) Appendicitis may be part of an inflammation of the large intestine (colitis), sometimes as a cause, at others as a sequel of this, and naturally its removal will have different results in the two conditions.

MORBID ANATOMY. Considerable variations will be found according to the severity of the inflammation ; from the findings at operation the following divisions may be recognized : (1) catarrhal, (2) phlegmonous, (3) empyema, (4) ulcerative, (5) gangrenous. In some instances the milder forms are no doubt earlier stages of those more severe.

(1) In the catarrhal variety little change is noted on the peritoneal surface, but the organ may be slightly congested. On slitting it up there will be some congestion and œdema of the mucosa, often confined to one part, *e.g.* the distal half ; there may be petechiæ or small ulcers, of the erosion type, in the mucosa, while fæcal concretions and conglomerations of threadworms are common. The last condition (threadworms) is sometimes found in cases with considerable constitutional disturbance (pyrexia, vomiting, &c.), though the local lesion appears mild.

(2) In the phlegmonous variety the whole or a considerable part of the appendix is red and swollen, the peritoneal coat injected and covered with plastic lymph or surrounded with sero-pus or thick pus, which is often not fæculent. On slitting up the appendix the whole wall is œdematous and infiltrated, the mucosa swollen and congested, but ulceration is seldom present. The condition is a cellulitis of the appendix due to a general infection of its wall spreading to the peritoneal coat, often of streptococcal origin.

(3) In empyema of the appendix the lumen is usually blocked by stenosis at some point from previous inflammation, the contents of the lumen being

FIG. 60.   Gangrenous appendix laid open   FIG. 61.   Acute gangrenous appendicitis
    to show the site of large concretion (a).   affecting child, one-third of the organ.
                              (From photographs.)

retained behind this, causing suppuration of the lining mucosa with effusion of muco-pus into the cavity, which becomes dilated behind the stricture. The appendix is dilated beyond the stenosis, congested, sometimes covered with lymph but often free ; the mucosa is congested and exudes pus.

Empyema is also found in the next varieties associated with local and general gangrene, blockage being perhaps due to a concretion.

(4) Severe local ulceration, often of a gangrenous nature, most usually is found at the situation of a large, hard, fæcal concretion (rarely are pins, seeds, &c., found in the centre of these), to the irritation of which the initial lesion is due. The appendix is red and distended distal to such concretion, later covered with lymph, surrounded with pus, and possibly perforated ;

the distal part of the appendix is dilated with fæculent muco-pus which may be leaking into the peritoneal cavity, the proximal part of the appendix being often practically normal, while opposite the concretion is a blackish-grey gangrenous ulcer.

(5) Gangrene of the whole or a large part of the appendix may be the later result of the previous type or arise as the termination of a phlegmonous inflammation when ultra-acute, or be due to blocking of the blood-supply by kinks, twists, or thrombosis of vessels dependent on acute inflammation. The gangrene may be confined to the mucosa or spread to the whole wall, the latter being probably simply a more advanced condition of the former. The congested, purple appearance with black, grey, or green patches and the foul pus distending the interior, which is completely black or grey, are unmistakable.

Bacteriology. Many organisms are found, as might be expected from the rich flora of the intestine, but the pathogenic organisms most usually found are the colon bacilli and streptococci, though certain anærobes are regarded with grave suspicion.

RESULTS OF APPENDICAL INFLAMMATION AND INFECTION. These may be divided into those affecting the appendix itself and those affecting its surroundings and more remote parts.

(1) The milder inflammations may clear up, leaving the appendix normal, or the inflammation may become more severe, the catarrhal passing into the phlegmonous or ulcerative form, the petechiæ becoming ulcers, which in turn may perforate or heal with scarring. The scarring of healed ulcers leads to strictures of the appendix in one or more places, and this pre-disposes to retention of fæcal and septic material and recurrent inflammation with ulceration or empyema : where the ulceration is more diffuse the mucosa may be entirely destroyed, the lumen of the appendix being occluded by fibrous tissue (obliterative appendicitis) ; where the appendix becomes gangrenous it may in rare instances be absorbed by the surrounding peri-toneum and so cured, but neither of these forms of natural cure is common and the risks of a spreading peritonitis developing are far too great to admit of such expectant treatment.

(2) This concerns the peritoneum, blood-vessels, and lymphatic drainage of the appendix. The peritoneum is unaffected in the milder, catarrhal forms ; where the inflammation is more severe, whether phlegmonous, ulcerative or gangrenous, peritonitis of varying amount is always present sooner or later. There is at first an exudate of plastic lymph which fixes the appendix to its surroundings, and especially the omentum, and minimizes the risks of perforation. Where the infection is severe the lymph may break down with formation of an abscess. Where the formation of adhesions is rapid the abscess may be well circumscribed and localized, but where infec-tion is very virulent there is no localizing of this sort and spreading peri-tonitis ensues. The bands of plastic lymph may contract and interfere with intestinal movements, causing intestinal obstruction, a not infrequent result of appendicitis which may occur as early as within three or four days,

though more often not for a couple of weeks at least. Around a circum-scribed abscess there is often a considerable collection of odourless, turbid fluid in the peritoneum which is not confined in any manner, while the surrounding intestines are reddened. This is a very benign variety of peritonitis, though diffuse, and the turbid exudate probably contains substances of an anti-bacterial nature, for such cases practically always do well after the abscess is opened and the prognosis is vastly better than in cases of ordinary diffuse peritonitis, where there are lymph and foul-smelling pus disseminated amongst the intestines. The possibility of spread into the peritoneal pouches should be borne in mind, viz. into the pelvis, amongst the intestines, or up along the outer border of the ascending colon to the subphrenic and subhepatic pouches.

Extraperitoneal infection occurs either from breaking down of infected glands of the ileo-colic group, forming a retro-peritoneal abscess, which is not very common, or the spread may be directly back through the peritoneum into the loin to form a perinephric abscess, or the infection may attack the iliacus and psoas, causing inflammation and possibly abscess of these muscles.

Infection of the blood-vessels (veins), by causing infective thrombosis, leads by embolism to :

(*a*) Pylephlebitis, or portal pyæmia, *i.e.* multiple abscesses in the liver.

(*b*) General infections of a milder nature, such as thrombosis of the pelvic and femoral veins (in some instances due to direct spread), pyelitis, hæma-turia, and possibly to catarrh of the gall-bladder (*see* Gall-stones), ulcera-tion of the stomach and duodenum, &c.

Clinically affections of the appendix may be divided into acute and chronic.

SIGNS OF ACUTE APPENDICITIS. These vary with the degree to which the infection is confined to the appendix or has spread to the surroundings. The initial lesion of the appendix gives, however, no sign of its severity ; thus the signs of a mild catarrhal appendicitis may be quite as severe, or more so, than those of an ulcerating form which may perforate in a few hours. The following is a convenient division :

(1) Early cases (often called catarrhal, which is a bad name, since often perforation occurs later and there is no way of judging at the onset how severe the affection really is).

(2) Cases with well-localized peritonitis around, forming a localized intraperitoneal abscess.

(3) Cases where the peritonitis, though local, is not circumscribed but diffusing.

(4) Cases with diffuse peritonitis (often called general peritonitis). The last variety is simply a later condition of (3) which has not become converted into (2).

The *onset* is sudden in acute appendicitis, usually more severe in the gangrenous sort, though this is by no means invariable. At the commence-ment there is abdominal pain of general distribution but settling down in the right iliac fossa. This is the earliest symptom, and if at the same time

there is definite *tenderness* in the right iliac fossa between the umbilicus and the anterior-superior spine (McBurney's point) it is fairly certain that the affection is appendicitis, though in the absence of other signs probably mild.

The *pulse* and *temperature* are raised to a varying degree, and of these the pulse is the more important indication of the severity of the lesion, as fever may be absent with severe lesions.

Vomiting is fairly common at the onset, but in the milder cases is often absent, while persistent vomiting points to a severe progressive lesion.

Constipation is very general, but often there is no irregularity in the action of the bowels, and quite a number of patients suffer with diarrhœa.

The appetite is always deficient and nausea is marked in the more severe types with or without vomiting. The tongue is foul and furred but not dry and brown unless the accompanying peritonitis is fairly severe.

The facial aspect varies from an appearance of slight discomfort in mild cases to the complete Hippocratic countenance where there is widely diffuse peritonitis.

Frequency of micturition is not infrequent owing to peritonitis spreading to the wall of the bladder or, later, from pyelitis due to blood-borne infection.

The condition of the abdomen and rectum gives the best indications as to the condition of affairs around the appendix, and in accordance with the grouping given above we have :

(1) In early cases where the peritoneum is unaffected there will be deep tenderness at McBurney's point, the patient wincing as pressure is made here, and there may be some increase of abdominal resistance on the right side, though hardly enough to call rigidity.

(2) Where there is a well-defined abscess or localized mass of adhesions there will be a well-defined, dull lump in the iliac fossa, which is tender to a varying degree and with some rigidity over it, these signs being less marked the more firmly circumscribed the abscess has become.

(3) With local diffuse peritonitis the signs are marked tenderness and rigidity in the right iliac fossa with impaired movement of the abdominal wall and a varying degree of dullness, where the condition is becoming an abscess ; this may spread further and become diffuse peritonitis or become circumscribed as in the last-described type of abscess.

(4) Where widely diffuse peritonitis is present the abdomen is rigid, does not move on respiration, and soon becomes distended ; the legs, especially the right, are drawn up ; tenderness is noted all over the belly and dullness in the right iliac fossa, spreading to the flanks and pelvis.

Rectal Examination. This is most important and should never be omitted in early cases of possible appendicitis, (1) for if the appendix be in the pelvic position there may be little tenderness or resistance to be discovered from the abdomen.

(2) Where a local pelvic abscess is developed either from a pelvic appendix or pus tracking down into the pelvis, a boggy, fluctuating, tender mass will be felt, and it is in these cases that rectal examination is most valuable, as the physical signs of pelvic abscess may be imperceptible from the abdomen.

(3) and (4). In diffuse peritonitis there will be some tenderness and stiffness of the rectal wall, and possibly a boggy mass may be made out consisting of the coils of intestine glued together with lymph and pus.

A leucocytosis is well marked where an abscess is present and in most cases of diffuse peritonitis, but this refinement is seldom needed to indicate the severity of the affection and necessity for operative measures.

It should be recognized that the onset of symptoms does not indicate the origin of the attack, since in some instances signs only commence at the moment of perforation or a small abscess may form without producing any marked signs, and this may burst some days later and symptoms commence at that date. Thus it is impossible to gauge the degree to which inflammation has advanced by the day of the disease, since we have no criterion for judging when the disease really started ; hence it is foolish to decide that it is dangerous to operate between certain days, as has been maintained by some surgeons.

Diagnosis. Appendicitis may be simulated by disease of the abdomen or thorax. Early or recurrent appendicitis may be confused with renal colic from stones in the ureter, but is to be distinguished by the radiating nature of the renal colic and its intermittence (appendicular colic may, however, also occur). The localization of the tenderness to McBurney's point also helps in the diagnosis.

Ovarian pain on the right side, coming on with menstruation in women, is associated with tenderness lower in the iliac fossa than with appendicitis, which, together with menstruation present or expected, absence of fever and rapidity of the pulse, will serve to distinguish.

The onset of an attack of herpes zoster in the lower dorsal nerves will give pain in the right iliac fossa, which may be confused with appendicitis, but the segmental distribution passing round to the back and absence of deep tenderness, fever, and rapid pulse will discriminate.

Appendicitis with local or spreading peritonitis must be distinguished from other perforating and phlegmonous lesions causing peritonitis, such as perforation of gastric and duodenal ulcers, gangrenous inflammation of the gall-bladder, twisting of ovarian cysts, and inflammation in and about the Fallopian tube. The history of dyspepsia or gall-stone attacks, the early localization of the tenderness and rigidity to the upper abdomen, the loss of liver-dullness where stomach or gut is perforated, will help to distinguish the former conditions, while examination of the pelvis and for vaginal discharge in women may give some clue to pelvic inflammations. In doubtful instances the ubiquity of the appendix should be remembered ; we have found it even adherent to the gall-bladder, and, as pointed out in discussing perforating ulcers of the stomach, it is always best to explore the appendix first.

The only lung disease likely to be mistaken for appendicitis is pneumonia, and then with cases of early diffuse peritonitis where perforation has suddenly occurred. The sudden onset with abdominal (referred) pain, vomiting, pyrexia, and abdominal tenderness is very similar, and in the

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early cases physical signs in the lungs are often absent. The face is the best guide to diagnosis, being flushed and bright-eyed in pneumonia with dilated and working alæ nasi, while in peritonitis it is dull, drawn, with sunken eyes and cold nose.

APPENDICITIS IN CHILDREN. This requires a few words because of the gravity of the disease if untreated in these little patients, the difficulty of diagnosis, and tendency for signs to intermit while the infection is still advancing, leading to procrastination on the part of the medical attendant and disastrous results.

The early signs are mild and likely to be taken for those of belly-ache due to injudicious feeding. Where the lower abdomen is tender and even slightly resistant, with rise of pulse or temperature, and especially if both be increased, appendicitis should be diagnosed and operation performed at once. Even if signs are clearing up in twelve to twenty-four hours operation is the wise course, for ulceration may be still active and advancing and the appendix may shortly perforate ; the results of perforation in children are worse than in adults as they are less able to withstand the initial poisoning from infection of the peritoneum, and rapidly succumb.

Prognosis. As already mentioned, it is impossible to estimate the severity of the lesion in the earlier stages, and hence unless operation be performed, satisfactory prognosis is impossible. This is an argument in favour of early operation, since with early operation the prognosis is almost always good. Prognosis is made partly on the findings at operation, partly on the appearance of the patient. The prognosis from operative findings depends on the extent to which peritonitis is spreading and on the form assumed by the peritonitis.

Diffuse peritonitis with redness and distension of intestine, turbid, odourless exudate associated with a fæculent abscess, and degrees of peritonitis less than this usually may be regarded as favourable. But loculated abscesses containing foul pus scattered amongst the intestines, *i.e.* diffuse, fibrino-purulent peritonitis, is associated with a tolerably high mortality, since drainage is difficult and the toxæmia grave. Where the patient's appearance and pulse are good, even with severe intra-abdominal conditions the prognosis is fair, but where the pulse is small and over 140, the face assuming the Hippocratic type, the abdomen distended, vomiting severe, and hiccough present, the prognosis is bad, though some even of these cases recover under careful treatment.

SIGNS OF CHRONIC APPENDICITIS. Under this heading are included relapsing or recurrent forms as well as appendicitis with symptoms chiefly referable to other organs, usually the large intestine and stomach.

(1) The *relapsing* is similar as regards signs to the mild early type previously described, and tends to improve after a few days, but shortly recrudesces again with increased pyrexia, pain, tenderness, rigidity and constipation, &c., and this may again subside or proceed to abscess or peritonitis.

(2) In the *recurrent* form the attacks are similar except that symptoms

clear up completely, though even where symptoms are absent it may be possible to detect a thickened or dilated appendix by careful palpation when the abdomen or rectum is examined.

A number of cases which have an acute onset belong to these groups and may recover on expectant measures, at least for a time. But as we cannot prognose with certainty the outcome of any attack or predict that no subsequent attacks will follow (on the contrary, subsequent attacks of varying severity are very common), in nearly all cases removal of the affected appendix will be strongly advisable.

(3) Where the lesion is spreading and affects the peritoneum it may still assume a chronic form, with matting of adhesions and much fibrosis about the appendix or about a small central abscess. These cases have a considerable resemblance to cancer or tuberculous tumours of the cæcum, as they present a well-defined mass in the right iliac fossa which is not tender and over which the muscles of the abdominal wall are not rigid. The sudden onset at the beginning of the affection helps to distinguish the condition from cancer or tuberculoma, but the diagnosis may only be made on the operating-table or even missed there, and the cæcum with a small appendix-abscess removed in toto.

(4) More aberrant groups are those which present symptoms referable to other organs ; the main types so far distinguished are the " dyspeptic " (appendicular gastralgia) and the form associated with colitis.

(a) The " Dyspeptic Type." The patient complains of pain coming on at some interval after meals, vomiting is uncommon, and the pain tends to radiate rather to the right iliac fossa than to the epigastrium or shoulder, as in the gastric and biliary types ; there is tenderness in the right iliac fossa. Test meals vary but the acidity is apt to be low. The diagnosis is often uncertain, the condition being confused with gastric and duodenal ulcer ; hence the importance of exploring the appendix when no lesion is found after examining the stomach, duodenum, gall-bladder, &c., and removing the organ if diseased. The conditions found are adherence, kinking, ulceration, dilatation, stenosis, &c.

(b) The " Colitis Type." In these cases there are signs of chronic affection of the large intestine, frequent stools with tenesmus and passage of blood and mucus in small quantities ; tenderness or enlargement of the appendix may be made out on palpation. In these cases it is often uncertain whether the appendicitis is the cause of the colitis or secondary to this. If primary its removal will cure the colitis when not too far advanced : if the appendicitis appear to be secondary there seems little use in removing it ; better is it to make use of the offending member, to wash out the large intestine by performing " appendicostomy." This form of colitis is connected with prolapse of the cæcum, abnormal folds of peritoneum binding down the ascending colon (Jackson's membrane), intestinal stasis (Lane), and viscero-ptosis, &c., the exact limits of all these conditions being most uncertain, and the reader is referred to a later section for a further discussion of these somewhat complicated matters.

Treatment of Acute Appendicitis. Early operation as soon as the services of a competent surgeon can be obtained, with removal of the appendix, is in most instances the counsel of perfection. The advantages of early operation are :

(*a*) In a large number of cases the abdomen may be closed without drainage, diminishing the risk of hernia, fæcal fistula, &c., as well as making convalescence a far shorter and less tedious affair.

(*b*) Although cases treated expectantly often get better, yet a good number will suddenly and urgently need operation later and this waiting will diminish their chances of recovery, to say nothing of the greater risk of abscess, hernia, thrombosis, &c.

(*c*) The patient's condition is better in the early stages than if operation be done later as a last resource to save his life.

(*d*) The appendix can be removed with certainty in early cases, and this is most important to ensure a complete cure.

In some quarters the idea is prevalent that it is dangerous to attack appendicitis in the acute stage between the second and fifth day or thereabouts. Our conclusions from several hundred cases is that the only danger lies in not operating on these cases. We have never yet repented of opening an abdomen for acute appendicitis, and have often been agreeably surprised when operating on patients whose symptoms were slight to find a far more severe condition present or threatened than could have been expected on the physical signs, and have little doubt that many of such cases have been saved by immediate operation which, had this been delayed, would have died or been exposed to great jeopardy and a prolonged and painful convalescence.

The mortality of the early operation in the acute disease is nearly zero ; when spreading peritonitis is present the mortality varies from 5 to 30 per cent., according to the severity and degree of spread of the infection. The conclusion is obvious : patients with a sudden attack of pain associated with deep tenderness of the iliac fossa lasting more than a few hours, whether there is much alteration in the pulse-rate and temperature or not, should be placed in bed at once in Fowler's position in order that if perforation occurs infection will spread into the pelvis rather than upwards ; food by mouth is stopped, hot water alone being given, while arrangements are made for removing the appendix as soon as possible. Purges and enemata are inadmissible. The diseased appendix is an insidious and deadly enemy, and as such should be attacked at once unless there are very strong contraindications, for removal of the diseased structure in the early stages will cure the disease with almost invariable success. There must be no waiting for a mass to form or severe vomiting, œdema, and redness of the skin to ensue.

There are cases, few in number, where operation is inadvisable, such as when appendicitis of mild or doubtful nature is found in patients suffering from other diseases, who are bad lives from an operative point of view, such as the subjects of failing heart, advanced bronchitis, renal disease, diabetes, advanced phthisis, &c., for the risk of the operation may be as great or

greater than the appendicitis, though if the latter appear severe, operation should be undertaken under local or intraspinal anæsthesia.

Such cases will usually be found in those of advancing years, and appendicitis is, on the whole, less virulent in them than in younger patients.

The main advance of treatment of appendicitis in the last few years has been in early operation, the Fowler position, and free administration of saline per rectum. The statistics given by Lett for the London Hospital show this clearly.

Ten years ago the mortality for acute cases other than abscess and peritonitis was 15 per cent., for abscess 8 per cent., for general peritonitis 76 per cent. : the results in a recent year were for acute cases other than abscess and peritonitis, mortality 1·7 per cent., for abscess 3·3 per cent., for spreading peritonitis 20 per cent., the whole mortality for the second series of seven hundred cases sinking from 26 to 4·3 per cent.—a notable advance.

Operation in the Acute Stage. The patient is anæsthetized with general or, if the condition be severe, local or intraspinal anæsthesia, and the abdomen opened by a muscle-splitting incision in the right iliac fossa or one through the sheath of the right rectus below the umbilicus, retracting the muscles inward or outward according to custom. We prefer the muscle-splitting incision where the diagnosis is tolerably assured and the paramedial (through the rectus sheath, displacing the muscle outwards) where there is some doubt as to what is inside, as the incision can be enlarged if necessary with less damage to the parietes.

The muscle-splitting incision starts by passing through the external oblique parallel to its fibres, the centre of the incision being at the point of junction of the outer with the middle two-thirds of the line joining the umbilicus and the anterior-superior spine. Clips are placed on the edges of the incised muscle and these retracted ; the internal oblique and transversalis are then divided at right angles to this and retracted with tissue-forceps ; the peritoneum is next opened. Where an abscess is present œdema of the muscles is noted as these are divided and there may be adhesions immediately under the incision, though in the majority of instances the peritoneum is free and easily opened.

A finger is inserted to feel for adhesions or a tense, boggy mass behind or to one side of the cæcum or in the pelvis, which will usually be an abscess but may simply consist of adhesions. Where no such mass is found the appendix is brought up to the surface by pulling out the cæcum and tracing the longitudinal muscular bands to their termination. Not infrequently at first the transverse colon is picked out by mistake, but has smaller pouches and thinner walls than the cæcum, while the ileum does not enter into its side. There may be some difficulty in reaching the appendix when it lies in one of the subcæcal pouches, as it often does when inflamed, and into which it may be stuck by adhesions. In difficult cases the mesentery of the appendix should be clamped and divided, rendering extraction more easy, or the appendix may be divided between clamps at its origin and

dissected back to its extremity. After dissecting up the appendix it is removed, clamping its origin close to the cæcum and tying off at this crushed part and cutting it away ; the stump is invaginated most easily by the Z suture (Fig. 78 B, p. 255). Where there is much lymph and pus about this invagination is not needed. Drainage is not needed where there is no exudate or only lymph or a slight amount of odourless, turbid fluid ; where there is foul pus about, a large drain-tube should be passed down to the bottom of the pelvis. The wound is carefully closed in layers, after tying off the mesentery of the appendix and other bleeding-points.

Where a mass is felt inside the abdomen or pelvis the technique is slightly modified to avoid soiling the peritoneum as the abscess, if one be present, bursts. Gauze-packs are placed round the swelling, walling off the
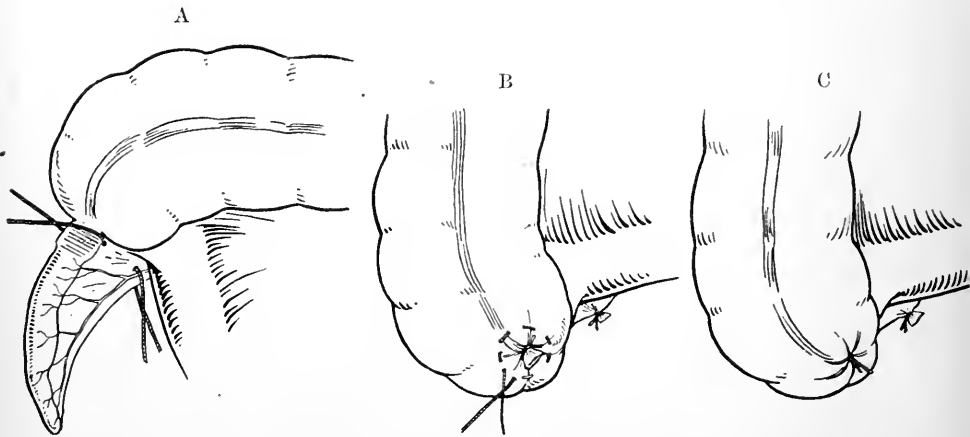
Fig. 62. Removal of the appendix. A, The appendix is crushed and tied, the meso-appendix also tied. B and C, Stages in invaginating the stump of the appendix with a purse-string suture.

loin and the pouch above the intestines to the inner side and the pelvis below. The abscess is then opened by burrowing the finger through the adhesions to the outer side of and below the cæcum. When pus is found it is assiduously swabbed away till the abscess-cavity is dry and a rapid but systematic search made for the appendix, which can often be seen or felt or traced from the cæcum as before : the appendix is quickly removed, clamping and tying the mesentery and crushing and tying the proximal portion of the organ ; there is no need to invaginate the stump in these cases, for fæcal fistula seldom arises from this part. Severely infected omentum around the appendix is best ligatured and excised. In some instances where the appendix is wrapped up in omentum it is possible to excise the whole mass after tying the omentum and the base of the appendix, and so remove a gangrenous appendix and abscess without fouling the peritoneum. Unless the abscess is removed *en bloc* as just mentioned, drainage should be established, passing the tube into the iliac fossa, loin or pelvis, according to the position of the abscess, and if the infection is

diffusing a drain should always go into the pelvis. The tubes should pass through the original incision ; it is useless making counter-openings in the loin if the abscess be in that situation, for such tubes do not drain. Operation on the above lines will serve for all acute cases whether peritonitis be present or not, and with practice the appendix can be removed in nearly every case, and this prime source of infection should always be taken away if possible. At the same time the operation should not take too long in its performance, or the shock added to the toxæmia already present will render the patient a ready prey to further spread of infection. In most instances the operation can be completed in seven to fifteen minutes, and rather than prolong matters unduly where the patient's condition is poor it is wiser to leave the appendix, simply draining the abscess ; if the appendix cannot be discovered in about five minutes it should usually be left and removed later. On this account, practice in abdominal surgery is important for these cases in order that the operation may be done thoroughly and quickly, since lives are lost by muddling inside the peritoneum, on the part of those whose experience is small.

Where the case has been left long and a large abscess is present in the iliac fossa and loin it is best to open the latter by a muscle-splitting incision, simply draining the abscess but running the finger round its cavity in case the appendix may be to hand and easily removable, but not making any determined attempt at its removal. After the abscess is dried out and the tube inserted there is no reason to leave the gauze packs in any longer, as the plastic lymph seals off the abscess and the exudation flows down the tube, there being no danger of infection spreading to the general peritoneal cavity ; while gauze pads, if left, are likely to set up great irritation, shown by vomiting, pain, and may lead to intestinal obstruction.

After-treatment. The patient should be propped up in the Fowler position after operations for any form of inflamed appendix. In cases where suppuration is present, whether localized or spreading, the position is imperative, for results have been far more satisfactory since the adoption of this posture. The importance of drainage by gravity into the comparatively resistant peritoneal pouch of the pelvis has already been mentioned ; in addition the patient may be turned on the right side to assist in drainage. This position may be retained for a couple of days in the milder infections, but where there is profuse suppuration a week or ten days should elapse before the horizontal position is permitted. In the milder conditions the bowels may be opened after two or three days, but where infection has spread to the peritoneum it is best to move the bowels early lest paralysis and atony of the intestine supervene. In cases where there is much collapse and diffuse peritonitis, saline infusion should be given, per rectum for choice, or if this be too irritable, subcutaneously into the legs, flanks, or submammary regions. At the same time attempts should be made to secure action of the bowels by giving calomel in half-grain doses hourly for six hours, followed by turpentine enemata and magnesium and sodium sulphate in dram doses.

Injection of strychnine, one-thirtieth of a grain four-hourly, should be given to promote peristalsis, while in some instances pituitary extract acts excellently in the same manner if given in doses of a cubic centimetre every four hours. Eserine may be used for severe constipation, but is likely to lead to urgent diarrhœa and collapse. By mouth, hot water alone should be given for twenty-four hours; nor should this be stinted unless swallowing water obviously increases the vomiting.

Drainage should always be arranged with a tube; gauze alone or in a tube is useless, and its insertion is only advisable where many adhesions have been torn across and there is much oozing or where the issues are too friable to stand ligatures: gauze should be removed in twenty-four hours.

The dressing should be changed as often as needed, which may be, for acute cases, several times a day at first; after two days the tube may be irrigated with peroxide of hydrogen, and in most instances removed after four days and replaced by one which only just passes through the abdominal wall.

Operation in Chronic Cases; Interim Appendicectomy. This will be needed either because expectant measures have been adopted or an abscess has been opened and drainage established but removal of the appendix proved impossible, or in cases where gastric, biliary, renal disease has been wrongly diagnosed at first.

The operation is done on the same lines as that advised in acute cases, splitting the muscles in the right iliac fossa; the amount of adhesions may render the operation quite difficult. The cæcum should be recognized and the tæniæ traced to the appendix, breaking through or dividing adhesions between ligatures according to their size and importance. The appendix is crushed, tied off, and the stump invaginated. There is some risk of tearing the cæcum in these operations; this is of little harm if noted at the operation and closed with sutures. Care should be taken to note any such mistake, or a fæcal fistula or peritonitis may result if neglected. Drainage is seldom needed unless a residual abscess be found or the intestine torn, when a small tube should be inserted to the site of lesion and removed after forty-eight hours.

Complications and Sequelæ. These seldom occur after early operation, being almost invariably the result of prolonged expectant treatment, and have been in part described under the results of appendical inflammation, but as they may occur in cases after operation, particularly where this has been delayed, the surgeon must be alive to their possible presence in cases which are not recovering satisfactorily after operation.

(a) *Peritoneal Complications.* (1) Pelvic abscess, indicated by irregular pyrexia and finding a boggy or fluctuating swelling in the rectum (rectal examination should be made every second day in cases where there is unexplained pyrexia and rapid pulse-rate after operation, as this is the most common complication of suppurative appendicitis treated by Fowler's position).

(2) Peritonitis and localized abscess amongst the intestines are shown by a distended, rigid abdomen with areas of dullness, constant fever, vomiting, and rapid pulse.

(3) Subphrenic abscess, usually on the right side, is evidenced by irregular fever, increased rate of pulse and respiration, and signs of compression of the base of the right lung.

It is necessary, then, where progress is not satisfactory to keep a sharp look-out on the rectum, abdomen, and base of the lungs, and if suppurative peritonitis be suspected, to explore for this as described under Localized Peritonitis and Subphrenic Abscess, &c.

(4) Intestinal obstruction, as shown by urgent vomiting, severe pain, absolute constipation and abdominal distension, low temperature and rapid pulse. This is due to rapid formation of bands of lymph or general matting of the intestines. Immediate laparotomy is needed in these cases and the bands must be freed, the distended intestine being emptied with trochar and cannula and the abdomen closed. Where there is a general matting of intestines, after freeing adhesions it is worth running in 5 c.c. of sterile olive oil or liquid vaseline to prevent further adhesions.

(b) *General spread*, whether mild, causing thrombosis of veins, or severe, resulting in pyæmia with secondary abscesses in the liver, pneumonia, empyema, &c., the treatment of which is considered under General Surgery.

(c) *Perforation of Viscera*. This occurs in a certain proportion of cases after operation and sometimes without operation. The viscera perforated are the cæcum, rectum, small intestine, or bladder, leading to fæcal or urinary fistulæ and severe cystitis in the last instance.

Perforation of viscera is sometimes the result of the severity of the inflammation, but not infrequently the result of pressure of a drain-tube against the inflamed organ, and we must again insist on the importance of removing the tube as soon as possible, often within two days, and if more prolonged drainage is needed, to shorten the tube so that it simply passes through the parietes into the peritoneal cavity. After four days there will be a good track in the path of the tube along which pus can freely exude : a watch must be kept that pelvic abscess does not develop after too early removal of the tube.

Should a perforation of the large intestine occur it will usually close in a few weeks without operation. Where a fistula persists in the large intestine or where, being in the small gut high up, it causes the patient to waste from diminution of the absorbent surface, it will be necessary to attempt its closure. This may be done by excising the fistulous part and suturing the portions of intestine, or where this seems too difficult and dangerous, to perform a lateral anastomosis between the intestine above and below the fistula, when it will generally close, care being taken not to exclude too much intestine or the amount of small gut available for absorption of food may be too small.

(d) *Incisional Hernia*. This is extremely rare unless operation has been delayed and severe infection is present so that suppuration and sloughing

of the abdominal wall takes place. Incisional hernia following appendix operations was more likely to happen when the old-fashioned plan of cutting through the transversalis and internal oblique across their fibres was employed instead of splitting them. The more rational muscle-splitting operation is less liable to be followed by this complication. The signs and treatment are discussed under incisional and ventral hernia.

(e) *Right inguinal* hernia sometimes develops after appendicitis and operation, from a weakening of the abdominal wall.

(f) *Cancer* of the appendix is not very uncommon, that is cancer of pathologists; the signs are those of acute perforating appendicitis, and examination of sections shows the characteristic changes found in cancer. Simple excision of the appendix seems sufficient for cure, and there is no need to perform a wide excision later on, so that from a practical stand-point the condition is of small importance.

AFFECTIONS OF ACQUIRED DIVERTICULA, PERICOLITIS, DIVERTICU-LITIS, ETC. Acquired diverticula are found in the large intestine usually in males over forty. They are situated in the mesenteric border of the gut, and are most common in the lower part, *i.e.* the descending colon and sigmoid, but may occur much higher up; we have found one at least in the cæcum.

The cause of these diverticula (Telling) appears to be a congenital weakness of the circular muscle of the colon and prolonged constipation, *i.e.* they are tension diverticula due to stretching of the intestine from internal pressure. These diverticula are often of no pathological significance, being only found post-mortem, but various changes may occur in them, usually associated with and caused by fæcal concretions, which present a close analogy with appendicitis.

These changes are (1) Acute ulceration and perforation, (2) Chronic inflammation with excessive production of fibrous tissue (pericolitis and perisigmoiditis), (3) the supervention of cancer.

(1) The *acute perforative* form presents signs similar to perforation of other ulcers of the intestine, viz. local peritonitis with abscess or diffuse peritonitis (the former presents a picture resembling appendicitis on the left side). No further description is needed except to state that owing to the position of the diverticula on the attached surface of the intestine a perforation is less usual than the next type.

(2) *Chronic Diverticulitis. Anatomy.* A tumour is found in and around the wall of the large intestine, hard, nodular, and often adherent to its surroundings, resembling closely a cancerous growth or a hypertrophic tuberculoma. This tumour consists of fibrous tissue originating around an ulcer in the depths of a diverticulum, which often contains a concretion.

The signs and symptoms are those of chronic intestinal obstruction, with a palpable tumour in the left iliac fossa. Or a tumour may be noted, while the patient suffers from some irregularity of the bowels not amounting to obstruction, sometimes passing blood and mucus. The chronicity of the case will help to distinguish from cancer, while the age is greater than is

usual with hypertrophic tuberculoma. But diagnosis is often uncertain, even when the abdomen has been opened.

Treatment. Excision of the mass with occlusion of the ends and lateral anastomosis gives excellent results. Where adhesions render excision impossible or dangerous, a lateral anastomosis to short-circuit the mass improves the condition, and the inflammation may subside when the passage of fæces no longer irritates the ulcerated surface.

(3) It has been found (Mayo) that a good many cancers of the large intestine take origin in these chronically inflamed diverticula, as will be described later, and this possibility is a further argument for excision of such tumours whenever possible.

AFFECTIONS OF MECKEL'S DIVERTICULUM. This appendage of the ileum, which is situated within three feet of the ileocæcal junction, is liable to inflammatory affections resembling those of the appendix. The lumen being greater than that of the appendix there is greater danger of gross extravasation of fæces, if perforation occur, and it is not tucked under the cæcum but free amongst the intestines, so that the risks of peritonitis are greater and the mortality heavier than with similar lesions of the appendix. The inflammation is often due to concretions, the presence of which may cause paroxysmal pain in the lower abdomen.

Where inflammation is severe and ulceration or perforation occurs the signs will be those of local intraperitoneal abscess or diffuse peritonitis starting in the lower abdomen. The treatment is operative, removing the offending diverticulum, having crushed and tied off the base, the stump being invaginated as usual, and draining if necessary. The possibilities of this diverticulum point to the necessity of examining the lower part of the ileum in case of peritonitis of the lower abdomen, not explained by the state of the appendix. In addition to these inflammatory lesions Meckel's diverticulum gives rise to various forms of intestinal obstruction as follows :

(*a*) By being twisted (volvulus) and so kinking the intestine at its origin.

(*b*) By pulling on the gut (kinking by traction).

(*c*) By becoming invaginated into the interior of the gut and behaving as a polypus and thus originating an intussusception.

(*d*) As already mentioned, stenosis of the intestine may be found at this point.

NEW GROWTHS OF THE INTESTINE AND RECTUM. These are rare in the small intestine and not uncommon in the large gut, being found more frequently as we descend the colon ; the most usual sites for a growth are the pelvic colon and rectum.

Innocent growths are quite rare. Lipomas, adenomas, fibromas, myomas, have been found and often cause no symptoms, but innocent tumours may project as polypi into the lumen of the intestine and be pulled down by peristalsis, thus forming the apex of an intussusception ; sometimes bleeding from the surface of an adenoma will bring the patient under observation : very rarely are innocent tumours of such size as to cause intestinal obstruction.

Malignant infiltrating growths are the usual type, and of these cancer is by far the most common. Sarcoma is usually found as a small round-celled growth or lymphosarcoma of the small intestine. The course is rapid ; an abdominal tumour forms with signs of intestinal obstruction. At operation it may be possible to remove the affected coil of intestine, but often there is too much invasion of surrounding structures, *e.g.* gut and bladder, to permit of this. Even when removable, the prognosis is very bad and recurrence may be evident before the patient has recovered from the first operation.

CANCER OF THE BOWEL. This originates as a columnar-celled cancer in which the fibrous elements may predominate, producing the sclerosed or scirrhus type, or the cellular elements may be most in evidence with rapid, prolific and exuberant growth.

Macroscopically three main types are found.

(1) The fibrosing sclerotic annular or ring cancer.

(2) Hypertrophic cancer.

(3) The malignant polypus where the growth projects mostly into the interior of the intestine.

(1) A ring cancer of the colon appears as if a string had been tied round the intestines as the growth involves the whole circumference of the gut. The thickening and induration are often but slight ; the results are blocking, which comes on slowly ; the intestine above the obstruction is dilated and hypertrophied, while that below is narrow, atrophic, and in some instances shrunken to the size of a tape.

(2) In hypertrophic cancer the wall is involved for a considerable part, or even the whole of the circumference, and is much thickened, nodular on the peritoneal surface, ulcerated within, cutting like an unripe pear. There is less narrowing of the lumen in these cases, and the early signs are due to the ulceration which causes frequency of defæcation, diarrhœa and the passage of blood and mucus in the stools, while constipation and diarrhœa often alternate. Later, signs of obstruction develop.

(3) The malignant polypus is localized to one part of the circumference of the bowel, and tends for a considerable time to project into the lumen of the latter rather than to infiltrate the wall : later such invasion takes place, and the condition assumes the form last described. These growths usually occur low down, *i.e.* in the rectum, causing tenesmus and passage of blood and mucus per rectum. Later, obstructive phenomena develop if not treated by removal.

Cancer of the large intestine is commonest in the rectum, then in the sigmoid loop, the cæcum is not infrequently affected, while the splenic flexure and hepatic flexures are less commonly involved.

SPREAD OF CANCER IN THE LARGE INTESTINE. The manner of spread of these growths gives indications of the direction in which to focus our attention in attempting to cure the disease by operation. There are four methods of spread :

(1) By infiltration along the lymphatics of the intestinal wall. In this

way cancer-cells may travel some distance without giving any macroscopical signs. Some observers state that such spread is to be found by special methods six inches and more from the visible end of the growth. This, in all probability, is only true of the more inveterate instances, since many cases are cured where much less than six inches on either side of the cancer are removed ; still the possibility of such extension indicates the necessity for a very wide removal, where it is possible without too great danger to the patient.

(2) *By dissemination via the peritoneum.* Once the growth has spread to the peritoneal surface of the intestine the cells are shed into the peritoneal cavity, and disseminate widely, forming secondary nodes in omentum, gut, &c., the presence of which is a contra-indication to any attempt at radical measures.

(3) *By the blood-stream along the portal vein to the liver*, which should be examined in all cases for secondary deposits before any large operation is undertaken, since secondary deposits render radical operations unjustifiable.

(4) *By the lymphatics.* It is in this respect that our knowledge has mostly advanced of late, and this advance in knowledge gives indications of the necessity for more radical operations, but at the same time shows the fallacy of expecting too much from even the most advanced excisions.

The lymphatic drainage follows very much the same course as the blood-vessels, and it will be remembered that the blood-supply of the large intestine is mostly derived from the superior mesenteric artery by means of the ileocolic, right colic, and middle colic branches, which supply the colon from the cæcum to the splenic flexure. Branches of the inferior mesenteric artery supply most of the remainder, *i.e.* the descending colon, iliac and pelvic colon and rectum, assisted by the middle and inferior hæmorrhoidals in the lower part. The lymph-nodes of the large intestine form three main groups :

(*a*) The paracolic glands lying close to the intestine at its attached border ; when these are enlarged they form a swelling continuous with the wall of the colon.

(*b*) The intermediate groups which lie along the course of the various colic branches of the mesenteric arteries.

(*c*) The main groups situated where these branches come off the main mesenteric vessels. The paracolic glands then form the first barrier to the spread of disseminating cancer-cells, but in some instances the lymphatics miss out the paracolic glands and run directly into the intermediate or main glands (Jamieson and Dobson), rendering the removal of these also necessary to perform anything like a complete removal.

The distribution in special regions is discussed later (pp. 225, 226).

Symptoms and Signs. Cancer of the bowel is most insidious in its origin, the early symptoms being slight and often not bringing the patient to the doctor for some time, and even when seen by the latter there is too much tendency to palliate symptoms till the time for successful cure by operation

has gone by. On the other hand the spread of cancer in this region is comparatively slow, and if diagnosed early the prospects of complete cure by excision are good. It is most important that the public as well as the profession should recognize this, for early diagnosis is the surest path to successful treatment. No middle-aged person should be treated for diarrhœa lasting more than a week without examining the rectum, and should the symptoms continue for a fortnight without some satisfactory diagnosis being made, the bowel should be examined as far as possible with the sigmoidoscope, and if nothing be found the abdomen opened and the condition explored. To palliate obscure conditions of intestinal disease in the middle-aged and old, till marked wasting or intestinal obstruction give a clue to the diagnosis, is simply to court disaster.

Symptoms attributable to the ulceration and the irritating presence of the growth are diarrhœa and the passage of mucus sometimes mixed with blood in the stools.

Sometimes constipation alternates with the diarrhœa, due to a slight amount of obstruction or to over-action of medicines given for the diarrhœa. Morning diarrhœa in middle-aged persons is very suggestive of cancer of the large intestine. These symptoms alone may be present for a considerable time. Later or without the former premonitory signs chronic intestinal obstruction may set in gradually, becoming more severe till it reaches an acute condition with tympanites, absolute constipation, vomiting, rapid pulse, &c. In other instances the later signs may be due to spread of the growth, viz. a fixed palpable tumour at the site of origin, nodular enlargement of the liver, ascites and secondary masses in the omentum, anæmia and wasting, all of which point to the growth being out of the range of radical operation.

Where the growth is lower down in the rectum or lower sigmoid (pelvic colon) tenesmus may be marked, i.e. a desire to defæcate with the result of only passing a little blood and mucus. In some instances the motions are narrow and " tape-like " from the small calibre of the stricture through which they pass. Of signs pointing to invasion of neighbouring structures we may find pain down the legs from involvement of the sacral nerves, frequency of micturition, cystitis, which may be agonizing if perforation into the bladder has taken place and a recto-vesical fistula is established. In such a condition flatus and fæces may be passed per urethram.

The large intestine should be examined digitally and with a speculum. With the finger a fungating mass on one wall of the rectum, a crateriform indurated ulcer, or a hard stricture surrounding the bowel may be felt. If no growth be felt it may be noted that the rectum is " ballooned," i.e. dilated and patulous. This condition is often found where there is a growth higher up, out of reach, probably owing to the paralysis of the rectum from the pressure of the growth on its nerves as they pass down ; ballooning may, however, be present without any growth. Where no abnormal conditions are found with the finger, the sigmoidoscope may be passed. This instrument is a tubular speculum with a lamp inside its

extremity (or light is reflected down from a lamp outside) and an arrangement by which air may be pumped in to keep the bowel above the speculum dilated.

The speculum is introduced through the anal sphincter with an obturator in its lumen, but after this is passed under guidance of vision, inflating the intestine as it is passed along.   Unless passed under such guidance there is grave risk of rupturing the coats of the rectum.   In this manner the inside of the large intestine may be inspected for twenty centimetres or more, and stricture or ulceration noted.   Finally, where symptoms persist more than a month and are not due to some form of dysenteric ulceration, exploratory laparotomy should be undertaken and the large intestine examined throughout its length.

Diagnosis.   Where the growth is beyond the reach of the finger and sigmoidoscope absolute diagnosis is impossible, and exploratory laparotomy essential.   When the abdomen has been opened and a tumour found in the intestine it has to be distinguished from a tuberculoma or chronic diverticulitis, which may be difficult.   Where the affection is in the rectum the condition must be distinguished from inflammatory stricture following on syphilis or gonorrhœa, or a sequel to fistula in ano.   In the latter varieties there is generally ulceration below the stricture, whereas in malignant stricture there is more often a margin of normal gut below the stenosis, unless the latter be at the anal margin.

At an exploratory laparotomy, any sort of chronic intestinal obstruction may be found, such as matting of intestine from old adhesions, bands stretching across the large intestine, &c., all of which demand operative measures.

TREATMENT OF CANCER OF THE LARGE INTESTINE.   Resection of the growth with a margin of six inches of intestine on either side, together with the area of lymphatic drainage is the ideal treatment, but in practice it is often necessary to be content with less extensive measures.   In many instances palliative operations are alone possible, but the relief thus afforded from the tortures of intestinal obstruction make them well worth while from the patient's point of view.

(1) *Palliative Treatment.*   The aim of such treatment is to divert the flow of fæces so that it no longer passes over the ulcerated growth, the result being that the latter is less irritated and grows less rapidly, while at the same time the danger of intestinal obstruction is averted and the patient succumbs peacefully from secondary deposits in the liver and elsewhere. Where the growth is in the rectum or lower pelvic colon such diversion of fæces is only possible by forming a permanent opening between the bowel and the surface above the site of obstruction ; such an opening is known as a " Colostomy."

Where the stricture is above the pelvic colon it is possible to " short-circuit " the tumour by forming a lateral anastomosis between the gut above and that below.   The easiest place to perform this operation is between the lower ileum and the sigmoid loop (ileosigmoidostomy), but

the transverse colon may be anastomosed to the sigmoid for a growth in the splenic flexure or the ileum to the transverse colon or growth in the cæcum or hepatic flexures.

(a) *Indications for Short-circuiting Operations, Colostomy, or Excision.* Where acute obstruction has supervened, as is not uncommon, on fairly mild chronic obstruction which has been left unexplored too long, colostomy will usually be indicated (especially where the following signs are marked), distension, vomiting, rapid pulse, shock. Colostomy is advised because it takes less time and causes less shock.

(b) Where laparotomy is done for chronic, non-urgent obstruction, a lateral anastomosis should be done unless the growth be too low down, when colostomy is indicated. At the same time note should be taken as to the possibilities for removal later ; *i.e.* as to the presence of secondary deposits in the liver, adherence to surrounding parts or involvement of the aortic glands. The importance of opening the abdomen in the case of growths of the rectum is clear, since these may appear operable and quite movable when examined per rectum, but abdominal exploration not infrequently reveals the futility of so doing, owing to the presence of widespread secondaries in glands, liver or peritoneum.

(c) Where on abdominal exploration the growth is found to be removable, if no obstruction be present excision may be carried out at once. Should, however, any degree of obstruction worthy of the name be present as shown by distension of the intestine above the growth it is better to drain the latter by lateral anastomosis or colostomy for ten days before proceeding to radical measures. Thus palliative may be the prelude to radical treatment in order to improve the condition of the patient. Lateral anastomosis has been described already.

(2) *Colostomy.* In this operation an opening is made into the sigmoid, transverse or ascending colon, according to the position of the obstructing growth. For growth in the lower sigmoid or rectum the sigmoid is used ; in performing colostomy for growth of the splenic flexure the transverse colon may be opened, while for growths of the hepatic flexure it is better to perform ileosigmoidostomy or right lumbar colostomy. Where colostomy is intended to be permanent the anterior type is more comfortable and easy to control than that in the lumbar region. Where colostomy is a prelude to an attempt at radical operation lumbar colostomy has the advantage of leaving the abdomen free from an infective sinus, though the possibilities of infection by operating in the presence of such a sinus are not great if care be exercised, and the anterior operation is far easier to perform and so more suitable in acute obstruction for which the operation is usually needed.

(3) *Excision of Cancers of the Large Intestine.* From a practical point of view these cases fall into two great groups : (a) those in which a thorough excision can be done and the continuity of the intestinal tube restored, and (b) those in which if a wide margin and the lymphatic drainage area be removed the patient must be left with a permanent colostomy. The latter

group contains growths of the lower sigmoid and rectum, and the advisability of a complete operation demands careful consideration.

(a) Growths of the first group may be considered from their situation as those of : (1) The cæcum and ascending colon ; (2) of the hepatic flexure ; (3) of the transverse colon ; (4) of the splenic flexure ; (5) of the descending colon and upper sigmoid. The account of the lymph-drainage and the operations advisable is taken from Jamieson and Dobson.

(1) The lymphatics of the cæcum and ascending colon drain into the paracolic glands at the margin of the colon and thence or in some instances primarily into the glands at the origin of the ileocolic and right colic arteries. The operation advised is (after opening the abdomen widely by paramedial incision and packing off the small intestine) to tie the ileocolic and right colic arteries (or their common origin) and companion veins ; strip these with the glands associated with them and the overlying peritoneum from the back of the abdomen to the intestine which is detached from its posterior attachments and removed, including the last six inches of the ileum, the cæcum, the ascending colon and the origin of the transverse colon, oversewing the ends of the gut and anastomosing the ileum laterally with the stump of the transverse colon or sigmoid.

There is little use in preserving the hepatic flexure, as the right colic artery will usually need division to ensure thorough removal of the glands about its origin. Care must be taken not to injure the ureter or duodenum in stripping the peritoneum and vessels off the posterior surface of the abdomen. Where the patient's condition is not good it may be advisable to commence the dissection by dividing the peritoneum at the outer side of the cæcum, mobilising the latter and stripping the colon with the vessels and glands inwards. Then, should the patient show signs of collapse, it is possible to remove the growth with less free margin and a smaller area of lymphatic drainage, but with less risk to life : a less complete operation than the former but possibly sufficient and better than allowing the patient to die of shock, since if the main artery be tied there is no going back, and the whole area of colon which has been deprived of its blood-supply must be removed.

(2) Where the disease is about the hepatic flexure the lymphatic drainage is into the paracolic glands and then into the glands of the mid-colic group.

Operation. It is necessary to divide the middle colic vessels close to their origin ; this renders about half the ascending colon and two-thirds of the transverse colon anæmic, and therefore the latter must be removed. It is not worth leaving the cæcum and remainder of the ascending colon as in any case the ileum must be anastomosed into the sigmoid. Consequently the cæcum, ascending colon and two-thirds of the transverse colon are removed, the ileocolic, right and middle colic vessels tied at their commencements and the whole removed with the glands.

(3) In the middle portion of the transverse colon all the lymphatics drain into the paracolic glands. Hence it is only necessary to remove some inches of colon on either side of the cancer and sufficient mesocolon to

ensure thorough removal of the paracolic glands. The ends may be joined by end-to-end anastomosis if of equal size.

(4) The splenic flexure drains into the paracolic glands, into the intermediate group of glands which are situated where the left colic artery crosses the inferior mesenteric vein, and also into the splenic glands which are outside the range of operative surgery. For growths here the left colic artery and vein are divided at the point mentioned (crossing of the inferior mesenteric vein) and removed with the glands and mesocolon, the left third of the transverse and most of the descending colon, and the cut ends united by lateral or end-to-end anastomosis. The fact that the splenic glands are often affected militates against complete success in many cases. The lymphatics of the descending colon have a similar drainage to those of the splenic flexure and the operation will be similar, but the section will pass lower through the upper part of the sigmoid.

(5) The drainage of the upper and middle parts of the sigmoid loop is into the paracolic glands and, to some degree, into the main glands along the inferior mesenteric artery. These are, however, affected later, and it seems only necessary to remove lymphatics as far as the intermediate group, tying the sigmoid vessels close to their parent trunk, but leaving intact the left colic and superior hæmorrhoidal vessels, dividing the gut through the lower part of the descending colon above and the lower part of the sigmoid loop below the growth. The operation is finished with end-to-end anastomosis, the descending colon and even the splenic flexure being freed by incising peritoneum to the outer side to render this more feasible. It is somewhat doubtful if the lower sigmoid will have a sufficiently good blood-supply if the superior hæmorrhoidal artery be divided, and if this be done to ensure a more thorough removal of glands it may be necessary to finish with a colostomy. Lately, however, cases are reported (Moynihan) where such complete removal with anastomosis has been successful.

(b) In the case of the lower sigmoid (pelvic colon) and rectum, a radical operation on the lines described, with thorough removal of the lymphatic drainage area, will almost inevitably terminate with a permanent colostomy, since the lymphatics drain not only into the paracolic and intermediate glands, but also into the main glands along the inferior mesenteric group. Cases do recover and remain well for years in which far smaller operations have been done, even as little as local removal of the growth being sometimes successful, but there is no doubt that unless a wide operation is done, recurrence will take place in most instances within two years. The operation advisable depends on the position and variety of the cancer and its degree of advance, as well as on the stamina of the patient. There is no use in submitting debilitated patients to what must always be a very severe operation : it is more reasonable to take some risk of recurrence, performing an excision which is less thorough, but accompanied with lower mortality. In certain conditions perineal excision of the rectum will certainly be the correct treatment.

SPREAD OF RECTAL CANCER AND OPERABILITY. The spread of cancer of the rectum is as follows (Miles) :

(*a*) Downwards into the perianal skin, ischiorectal fat, external sphincter.

(*b*) Laterally into the levatores ani, retro-rectal and internal iliac glands, prostate, bladder, vagina, cervix uteri, broad ligament.

(*c*) Upwards into the mesorectum, inferior mesenteric glands, and pelvic peritoneum. The main indications that radical operation is out of the question are a fixity of the growth and secondary deposits in the abdominal viscera. Fixity of the growth is estimated by the finger in the rectum, bearing in mind the spread, not only up and down, but also laterally as mentioned above. Adherence to the bladder or prostate puts radical measures out of court : adherence to the sacrum is serious, but may be overcome ; lateral fixity is less important, as excision may be wide in this region.

Preliminary laparotomy is always advisable even if it be decided not to remove the growth by this route, since only in this manner can invasion of the lumbar glands, liver and peritoneum be accurately ascertained, while a preliminary colostomy may be performed, which is often advisable as the growth may be washed out through this and risks of infection at the later operation minimized. Two varieties of operation will be considered : (1) the abdomino-perineal, and (2) the perineal.

(1) *Abdomino-perineal Excision of the Rectum and Sigmoid.* After this operation the patient has a permanent colostomy. Attempts to bring down the colon to take the place of the rectum are seldom satisfactory because so much of the mesosigmoid has to be spared to ensure a sufficient blood-supply to the rectum that the operation is not very radical. If then a really radical attempt is to be made the patient must be prepared for this after result, which is by no means bad ; if the colon be brought through the rectus muscle, split for the purpose, a good sphincter action is obtained. All the sigmoid loop except the part used in the colostomy should be removed, as the blood-supply of the lower part is involved in the removal of the lymphatics.

In most cases, especially if there be any signs suggesting obstruction, a preliminary colostomy should be performed ten days before.

Operation (Miles). Under intraspinal anæsthesia for choice, and in the Trendelenberg position, the abdomen is opened below the umbilicus, and the intestines packed off. The inferior mesenteric vessels are tied and divided above the lower sigmoid branch and the mesosigmoid divided.

The sigmoid is divided below the colostomy (if this has been made) and the ends invaginated. Where no colostomy has been made already, the lower end of the upper segment of sigmoid is brought out through a small incision through the rectus and secured with a few sutures. This may be opened at the close of the operation so that flatus does not accumulate.

The fat and glands are removed from the bifurcation of the common iliac artery downwards, the vessels in the edge of the mesosigmoid secured, and the operation is now nearly bloodless. The peritoneum is divided on

either side of the mesosigmoid and the incisions carried down to the recto-vesical pouch, where they meet around the rectum in front; the sigmoid and rectum with the mesorectum and glands are dissected off the sacrum to the sacrococcygeal joint, avoiding the left ureter; the lateral peritoneal attachments of the rectum are divided, the middle hæmorrhoidal vessels secured, and the dissection carried down to the levatores ani. The lower segments of pelvic colon and rectum are then pushed down into the pelvis, and the peritoneum united over the top. The abdominal wall is closed and the first portion of the operation is complete. The patient is placed on the right side, and the perineal operation commenced by placing a purse-string round the anus to prevent escape of fæcal contents. The skin incision is carried round the anus at some distance, and up over the coccyx in the median line. The coccyx is removed, and the levatores ani cut through near their origin at the white line, and the rectum dissected from the sacrum, prostate or vagina, and with the fat of the ischiorectal fossa removed after securing the vessels. The skin is brought together with sutures, and a tube inserted for thirty-six hours.

(2) *Perineal Excision of the Rectum.* A preliminary colostomy is advisable both for rendering the parts more aseptic by lavage and relieving obstruction. The patient may be in the lateral position or in that described as the reversed Trendelenberg, *i.e.* lying on the face with the buttocks raised, the head and trunk hanging down in one direction while the legs hang in the other. An incision is made encircling the anus from the sacro-coccygeal junction, the coccyx removed and the levator ani defined and divided well away from the rectum; the latter is freed from the sacrum behind to the prostate or vagina in front (a sound in the urethra or a finger in the vagina being helpful at this stage). The peritoneal pouch in front of the rectum is opened and the peritoneum cut through at the sides till the mesorectum is reached; this is divided close to the sacrum, and the rectum pulled down till a part well above the growth is in the perineum. The superior hæmorrhoidal artery is tied, the peritoneum sewn to the rectum well above the growth, and the levator ani sutured to the rectum below this, to restore the pelvic floor. The rectum is cut across at least an inch above the growth, and the edges sown to the skin.

In some cases it may be possible to spare the external sphincter and its nerve-supply or to leave the anal canal and join the lower end of the rectal stump to this. In a certain number of cases sphincter control will be regained, and in a few instances where the growth is of the malignant polypus type local removal of the tumour without even taking the whole circumference of the bowel has met with permanent success.

The same criticism applies to all purely perineal operations, from the mere perineal excision without any removal of bone to the larger attacks where the lower third of the sacrum is removed or reflected as a trap-door; and that is that sufficient notice is not taken of the manner in which cancer of the rectum spreads downwards and laterally, hence a very large number of cases operated on in this manner will recur (Miles).

The abdomino-anal operation is also faulty in the same respect.

In this form of operation the rectum is excised with the growth, beginning in the abdomen : the pelvic colon is then mobilized and the stump brought down through the anal canal, which is denuded of its mucous membrane. Here, also, in order to obtain a working perineal anus the excision in the pelvis is incomplete.

THE QUESTION OF AN ARTIFICIAL ANUS.   If an anus in the perineum has not got sphincter control, it is less pleasant than a well-made inguinal or mid-line abdominal anus (colostomy), and a sacral anus, such as often results from the larger perineal or transacral operations, is an abomination. Before operating, the possibilities must be put honestly before the patient. Where the growth is small and the patient in poor condition, unlikely to withstand a large operation, it may be possible to excise part of the rectum from the perineum and leave the sphincter power intact, but the far greater probability of recurrence should be explained, and also that the return of sphincter control is by no means certain, even after an incomplete operation. The condition of a patient with a well-planned, permanent colostomy is not so bad as is sometimes depicted, and by washing out the bowel every morning and taking care as to diet, the anus may be kept quiet and clean for the rest of the day.

The relative merit of these operations turns largely on the relation of the immediate mortality to the percentage of recurrences.

Tuttle gives the following primary mortalities : perineal excision, 13 per cent. ; sacral excision, 23 per cent. ; abdominoperineal, 40 per cent.

Edwards gives the sacrococcygeal route as having a mortality of 5 per cent., recurrences being 33 per cent., and claims about 50 per cent. cures. Cripps gives 35 per cent. cures by the same methods.

Miles found a recurrence rate of 96 per cent. in sacroperineal operations, only 6 per cent. being cured.   On the other hand this writer gives a primary mortality of 30 per cent. for the abdominoperineal method, but only 10 per cent. recurrences or 60 per cent. cures. This would point to the more complete operation being that for choice where the patient has a reasonable prospect of surviving ; especially as this operation is feasible in more advanced conditions, where the growth is already to some degree outside the bowel. It may be pointed out that half the cases at least which come under notice are already too advanced even for this wide-reaching operation.

Where the anal canal alone is affected, the growth is a squamous-celled epithelioma, and perineal excision may suffice, clearing out the hollow of the sacrum and removing the inguinal glands, but to get a satisfactorily wide margin the anal sphincter must be removed, leaving a poor sort of anus, and hence in these cases also the more complete operation finishing with colostomy should be advised.

Finally it may be noted that as in cancer of the stomach mere enlargement of glands does not prove that these are malignant, as chronic infection

from the ulcerated surface may cause such changes, and unless very gross or obviously malignant, mere enlargement of glands does not bar radical operation.

INTESTINAL OBSTRUCTION

By intestinal obstruction, or, as it is sometimes called, *ileus*, is meant a condition in which the passage of intestinal contents is interfered with to such a degree that not only solid and liquid fæces are unable to flow along the lumen, but even the passage of flatus is greatly impeded or altogether stopped. Associated with blocking of the lumen or other hindrance to the passage of intestinal contents, there is frequently an interference with the blood- and nerve-supply of the affected portion of intestine, which may, indeed, be the prime cause of the failure of the passage of the contents. Thus ileus is to be separated from constipation, in which there is merely a delay in the passage of solid fæces, possibly of weeks or months' duration, but in which the passage of flatus, and the blood- and nerve-supply of the gut are not interfered with to any appreciable extent. Furthermore, in constipation the stagnant or slowly moving solid fæces are in the large intestine, whereas in the condition of ileus the liquid contents of the bowel may fill large or small intestine or both, according to the form of obstruction present. Intestinal obstruction is, therefore, a clinical state depending on a great variety of pathological conditions, a number of which have been already noted.

Rôle of the Intestine from a Surgical Standpoint. The small intestine is being filled at constant intervals by the outflow from the stomach, the bile and pancreatic juice, at its upper end, as well as by its own secretion, and is essentially the organ for absorbing dissolved or emulsified solids. Its contents are liquid and undergo fermentation from the action of organized and unorganized ferments, the former producing fæcal decomposition products. The large intestine is the organ for absorbing excess of water no longer needed in the process of absorption, and is the " drying ground " (Barnard) for the fæces, hence the solidity of fæces in this portion of the intestine. These facts have some bearing on one symptom of intestinal obstruction, viz. vomiting. Seeing that the great bulk of liquid matter contained in the small gut enters at its upper end it follows that the higher up the obstruction, the less chance there is of the liquid digested matters being absorbed, and the more rapidly the intestine is distended with fluid, and the more urgent is the vomiting. Thus in obstruction of the jejunum vomiting is copious, but in cases of dilatation of the stomach (duodenal obstruction) enormous, whereas in cases of obstruction low down the large intestine the vomiting comes on later and is only urgent when the patient is *in extremis*, since the large intestine is able to absorb the greater part of the liquid matter from the intestinal contents as it passes down. Another important function of the intestine is the production and absorption of gas which plays no mean part in the condition of ileus, over-production of gas causing distension of the intestine, which is described clinically as " meteorism " of " tympanites." This distension of the intestine with

gas is not readily caused by mere blocking of the lumen of the intestine, as Kader has shown experimentally.

Interference with the blood-supply of the gut, alone or in addition to blocking of the lumen is needed before tympanites results. The ligature of a vessel of any size supplying the intestine leads to the production of an increased amount of gas in the segment supplied and distension of the latter (largely owing to paralysis of the wall), whether the lumen is obstructed below or not. It follows from this that where the blood-supply, as well as the lumen, of a loop of gut is blocked, e.g. as in volvulus or snaring under a band, there will be much more distension of the affected part than if simply the lumen be blocked, e.g. by a foreign body.

Ætiology. Ileus or acute intestinal obstruction is a clinical condition associated with various lesions of the intestine, not always with mechanical blocking. For this reason the term ileus is preferable as a clinical term since in several varieties of this affection there is no obstruction in the strict sense at all. There are two main groups of causes leading to ileus :

(1) Those affecting the nervous or neuromuscular apparatus of the gut, leading either to paralysis or more rarely to spasm of the intestinal wall, and sudden stasis of the intestinal contents (adynamic ileus).

(2) Those which affect the gut by mechanically blocking its lumen or blood-supply or both (true intestinal obstruction).

(1) Under this heading are included paralysis of the gut due to :

(*a*) Peritonitis, where the intestinal wall is poisoned by toxines.

(*b*) Such conditions as severe contusions of the abdomen, twisting of ovarian cysts, spleen or omentum. The paralysis in this type of case is often similar to that first mentioned, *i.e.* a peritonitis, or may be the result of reflex inhibition.

(*c*) In certain nervous diseases, *e.g.* tabes, paralysis of the intestine and signs of ileus are noted.

(*d*) Chronic toxæmias, such as uræmia from renal inadequacy, sometimes cause ileus.

(*e*) Spasm of the intestine is sometimes found in hysterical subjects (enterospasm) and in chronic lead poisoning.

(2) In the second group (true obstruction) are found :

Acute Obstruction, or Mechanical Ileus : (*a*) Internal strangulation.

(*b*) Acute kinking or stenosis.

(*c*) Volvulus.

(*d*) Intussusception.

(*e*) Impaction of foreign bodies.

(*f*) Mesenteric thrombosis.

(*g*) Ileus supervening on chronic obstruction.

Chronic Obstruction : (*a*) Blocking of the gut from without.

(*b*) Strictures, simple or malignant.

(*c*) Impacted fæces and foreign bodies.

(*d*) Chronic intussusception.

(*e*) Idiopathic dilatation of the colon.

Finally the ultrachronic conditions associated with adhesions, kinks, Jackson's membrane, visceroptosis, &c., which are often described as *intestinal stasis* (Lane), will be considered.

It is the second group of conditions that we intend to discuss in the present section. The first group have been dealt with under Peritonitis and Abdominal Injuries. Cases of obstruction of the bowels due to mechanical causes may be divided into acute and chronic, the former coming under the heading ileus, while the latter are very different in their course, signs and symptoms, and are discussed in connexion with ileus because in practically every case chronic will pass into acute obstruction or ileus if unrelieved. The main differences between acute and chronic obstruction are as follows : in the former the lumen of the intestine is suddenly blocked, and in most examples there is also interference with the blood- and nerve-supply, while in chronic obstruction the lumen of the intestine is slowly or intermittently obstructed, the blood-supply being but little affected. When, however, the diminishing lumen of the gut is suddenly and completely occluded the condition passes into that of acute obstruction, and does so the more rapidly the higher the block is in the intestine. There are considerable variations in the rapidity of the course in different forms of obstruction of the bowels.

ACUTE INTESTINAL OBSTRUCTION. MECHANICAL ILEUS. *General Pathology.* The intestine may be considered, (1) at the site of obstruction, (2) above and (3) below this.

(1) At the site of obstruction the condition varies with the type of obstruction present, and will be treated in greater detail in discussing the anatomical forms of ileus. Briefly, if a loop of intestine is suddenly cut off, as it were, from the remainder by snaring under a band or passing through an aperture or by being twisted on its pedicle the effect is first to dam up the venous return of venous blood producing œdema, distension with gas, blueness and blackness of the loop affected, and exudation from its peritoneal surface more or less blood-stained according to the severity of the constriction or strangulation. When the blood-supply is sufficiently impaired local death ensues and the colour alters from black to green and grey, and there is a notable odour of dead tissue to be perceived when exposed at operation. The death of the intestinal wall is followed by peritonitis, at first local, but rapidly spreading. Where the obstruction is due to blocking of the lumen alone, the local effect may be slight, but the pressure leads sooner or later to bruising, œdema, or necrosis of the part subjected to pressure, with local peritonitis.

(2) Above the site of obstruction the gut gradually fills with intestinal contents which cannot pass on, and so stagnate ; putrefaction goes on rapidly in the stagnant mass, which soon acquires the character of thin, liquid fæces. The gut, unable to force its contents onward, becomes dilated, red, and fairly soon paralysed, partly from over-distension, partly by toxic absorption. Such paretic gut, if not too much affected, soon recovers its tone if promptly emptied at operation by tapping or relieving

the obstructing band, &c. (this being one of the important parts of the treatment), and if not emptying readily recovery is unlikely.

(3) Below the obstruction the intestine is small, pale and contracted, but shows active peristalsis, and may not be much larger than a stout penholder. This marked difference in size and appearance is a valuable sign when performing operations for obscure but acute affections inside the abdomen, for if one finds one loop of gut small, pale and contracted, and showing active peristalsis while another is large, red or purple, distended and motionless, yet without any inflammatory exudate on the surface, there is almost certainly a mechanical block below the large and above the smaller loop. Later the red, distended gut gives out an exudate of serum and lymph as peritonitis develops.

Clinical Aspects. The cardinal signs of mechanical ileus are : (1) pain ; (2) shock ; (3) vomiting ; (4) constipation ; (5) the abdominal facies. Later, (6) abdominal distension and tympanites ; (7) tenderness with rigidity, and possibly (8) a palpable tumour. It is evident, then, that the condition bears a considerable resemblance to acute peritonitis, and a consideration of the various signs will help to differentiate the two conditions (*see* page 113).

(1) Pain comes on very suddenly, and is often referred to the umbilical region, nor does it tend to be localized later to some other part of the abdomen, as where there is peritonitis about an appendix or gall-bladder. The pain is often very severe, and may be (*a*) constant, for example, where a loop of intestine is snared under a band or through an aperture ; or it may be (*b*) paroxysmal (*i.e.* a colic) where something is being forced down the intestine by excessive peristalsis, such as a foreign body or an intussusception. Paroxysmal pain suggests obstruction, but constant pain may be due either to this or peritonitis.

(2) Shock is very variable, depending on the severity and extent of the damage and the resistance of the patient's sensorium to afferent stimuli. Pallor, cold extremities, pinched clammy face of the abdominal type, and small, quick pulse are common, but may pass off for a time after the onset, particularly if morphia has been given. It is important, then, not to administer this drug till a diagnosis has been made or it has been definitely decided to open the abdomen. Once it is decided to operate, morphia is an excellent drug in the presence of shock. The absence of grave shock must not lead one to believe that ileus is not present, as some patients show but little signs of it at first.

(3) Vomiting is a prominent sign and occurs fairly often at the onset, being then probably of reflex origin and due to the sudden shock of the obstruction by whatever caused. As the affection proceeds vomiting becomes more urgent, the vomitus consisting first of stomach contents, then of bilious material, then of brown liquid, later of liquid fæces. Vomiting is especially pronounced where the obstruction is high, as in cases where the obstruction is of the small intestine, and depends on the lessened capacity of the gut to retain its contents. These last become fermented by putrefactive

bacteria, and so thin, liquid fæcal matter is produced, which from sheer bulk and because it cannot escape below overflows into the stomach, and by its irritation causes vomiting. Where the large gut is obstructed, vomiting is a far less prominent symptom until the patient is far advanced on the road to destruction.

(4) Constipation is in most cases absolute after the first few hours, *i.e.* not even flatus is passed. It is not uncommon, however, for the bowels to be opened shortly after the onset, and if the block of the lumen of the bowel be only partial the latter may be opened at intervals all through the attack. The intestine above the obstruction becomes distended with fæculent putrefying contents, liquid and gaseous in nature, and such material readily escapes through any small aperture in the obstruction. Constipation may be tested in doubtful instances by giving two enemata within an hour of each other ; the first often brings away fæces, but if obstruction be present the second will not bring away even flatus. As regards passage of flatus, the normal person hardly notices whether flatus be passed or not, but when absolute constipation is present there is intense desire to pass flatus associated with spasmodic pain of the colic type, and in spite of this no flatus is passed by rectum, but may regurgitate by mouth. Hiccough is sometimes a painful symptom in the later stages.

(5) The facies is similar to that described for peritonitis, and is of great importance in early diagnosis. Where other signs are equivocal the presence of the " facies abdominalis " should turn the scale in favour of laparotomy.

(6) Seldom is distension of the abdomen noted for two or three days and it is then due to the distension of the intestine above the obstruction or early peritonitis. In cases of volvulus, however, where the blood-supply of a large loop of intestine is affected the latter distends rapidly with gas, causing early and rapidly increasing tympanites.

(7) Tenderness and rigidity are signs of inflammation of the peritoneum, and are not present in the early stages of obstruction of the bowel, and when present show that matters are already advanced, and that prognosis is grave. The bowel must be considerably damaged to show an inflammatory reaction. Volvulus is an exception to this, for in these cases we find rigidity and tenderness earlier than in most varieties of ileus of obstructive origin, the reason being that the loop of twisted intestine becomes greatly distended with gas, and to such an extent that the abdominal wall is stretched and rendered tense, while at the same time, owing to the great interference with the blood-supply of the gut, inflammatory response is rapid, and tenderness due to peritonitis results early.

(8) An abdominal tumour is uncommon in most varieties of intestinal obstruction. In most cases of intussusception a tumour can be made out on palpation, and in some cases where a loop of gut is strangled under a band or inside an internal hernia it may be so distended and œdematous as to form a palpable resonant tumour. Foreign bodies and new growths which cause obstruction may occasionally be felt on abdominal or rectal examination.

GENERAL DIAGNOSIS OF ACUTE INTESTINAL OBSTRUCTION. Early diagnosis may not be easy, but is of the highest importance, since the treatment of these conditions is always operative, and the sooner the better.   Operation for acute intestinal obstruction should be performed within twenty-four hours, in which case the prognosis is fairly good, but every hour of delay adds to the gravity of the outlook.   The conditions most likely to be confused with obstructive ileus are colic, nervous diseases, and acute inflammatory affections of the peritoneum.

(1) Colic tends to be paroxysmal with periods of complete relief, while in cases of ileus, though there may be periods of remission, the pain never completely ceases.   Vomiting may be associated with colic, but never assumes the urgent bilious and fæculent type noted in obstructive ileus. If the facies and degree of shock are not sufficient to point to obstruction the absolute constipation and failure to pass flatus after a second enema should make matters clear.

(2) Of nervous diseases the most important affections are " tabetic crises," in which vomiting and severe abdominal pain are marked.   The absence of shock and absolute constipation will decide the diagnosis apart from the absence of knee-jerks, pupillary affections and Romberg's sign.

(3) Acute inflammatory lesions of the peritoneum, e.g. appendicitis, perforative lesions, &c., are distinguished by the rigidity and tenderness of the abdomen, which are marked from the onset, while these signs only come on later in cases of obstructive ileus : pyrexia is usually present in inflammatory lesion, though it should be remembered that the temperature may be subnormal in severe lesions of the peritoneum, just as it usually is where obstruction is present.   The diagnosis from peritoneal inflammations is of less importance if one admits that the treatment of these also should be early operation, and this is an argument in favour of early operation for acute appendicitis, for to treat a supposed case of appendicitis on expectant lines till driven by the increasing severity of signs to operation, and then to find that it is really a case of obstructive ileus, is a tragedy ; and it must be admitted that until the abdomen is opened it is not possible to be absolutely certain of the lesion which will be found within.   Obstructive ileus may be a sequel to inflammatory conditions or exist coincidently with these either before or after operations, and where operation has already been performed the condition is apt to escape the surgeon's vigilance unless great care be exercised.   In cases of this type where after operation vomiting persists and becomes urgent, brown, and foul, where the pulse rate rises and constipation is great and abdominal facies is marked, there are three possibilities : (i) spreading peritonitis, in which case there will be fever, and the abdomen will be rigid, tender and distended ; (ii) internal hæmorrhage, in which case pallor and breathlessness will be noted ; (iii) intestinal obstruction, in which condition the abdomen will be soft, but slightly tender, constipation absolute, and the general state of the patient worse than the appearance of the abdomen would warrant.

It must be further recognized that obstruction is a not infrequent

complication of acute peritonitis, *e.g.* of appendical origin, owing to the contraction of recent deposits of lymph, which fix and glue together the intestines, and it is of the greatest importance to recognize this condition (especially where operation has already been performed) as being due to blocking of the intestine by organic obstruction and not merely from atony and paralysis : since for obstructive ileus operative measures hold out the best hope of recovery, while for atony operation is best avoided.

ANATOMICAL VARIETIES OF OBSTRUCTIVE ILEUS. (*a*) Acute strangulation or snaring of a loop of gut, whether by a band, through an aperture, or into an intraperitoneal hernia (strangulation in an external hernia is exactly similar in pathology).
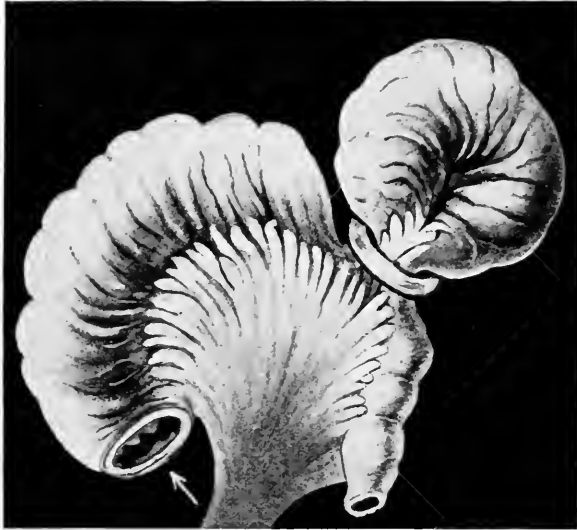
FIG. 63. A small loop of intestine snared under a band. Note the distended gut above the snared loop and the contracted empty part below.

(*b*) Acute stenosis or stricture of the gut, which is bent over a band or sharply kinked by an adhesion.

(*c*) Volvulus or twisting of one or more loops of intestine.

(*d*) Intussusception or telescoping of the bowel.

(*e*) Impaction of foreign bodies.

(*f*) Blocking of the blood-supply of the intestine, *i.e.* thrombosis or embolism of the mesenteric vessels.

(*g*) As a termination to chronic intestinal obstruction.

(*a*) STRANGULATION OF A LOOP OF GUT BY SNARING. This may take place in various ways and by different mechanisms.

(*a*) *Snaring by Bands.* Bands are always in some degree the result of past inflammation. Thus normal elongate structures, such as the appendix, Fallopian tubes, quasi-normal structures such as Meckel's diverticulum, become attached at their free ends by inflammatory processes, and thus

form apertures through which loops of intestine may pass and become strangulated. More commonly bands are the result of strands of lymph which organize into cords and are attached to the mesentery, parietes, omentum, or intestine, or may attach any of these together, the result being a band or cord by which loops of gut may be snared. These bands occur most frequently where peritoneal inflammations are most prevalent, *i.e.* around the appendix and Fallopian tubes, about the root of the mesentery from inflammation in tuberculous glands, in the appendices epiploicæ, or about diverticula of the sigmoid, &c.

(*b*) *Apertures* through which prolapse and strangulation of gut may take place may be congenital or due to injuries, including surgical operations, and are found in the omentum or mesentery. It therefore behoves the surgeon to sew up any holes which he may have made in these structures during abdominal operations.

A good example of this sort of aperture is that made in the transverse mesocolon, to perform the operation of posterior gastro-jejunostomy.

(*c*) *Strangulation in Peritoneal Pouches or Internal Herniæ.* Strangulation sometimes happens from intestine passing into the lesser sac through the foramen of Winslow ; more common sites are the pouches about the duodeno-jejunal junction and the subsigmoid and retrocæcal regions.

We follow here the account given by Moynihan :

(1) The peritoneal fossæ described about the duodeno-jejunal junction are legion, but only two are of surgical importance, giving rise to the formation of internal herniæ.

(*a*). The *left paraduodenal hernia*, which appears sometimes to be formed in the left paraduodenal fossa of Landzert. The mouth of this fossa lies to the left of the duodeno-jejunal junction and is encircled by the inferior mesenteric vein below, to the left, and above, while the duodenum lies to the right. The sac, when there is a hernia in this pouch, develops upwards and to the left, and may contain from one loop to practically all the small intestine.

(*b*) The *right paraduodenal hernia* is stated to arise in the mesentericoparietal fossa of Waldeyer, and has its mouth below the transverse part of the duodenum, the superior mesenteric artery lying in front, and the aorta behind. The pouch extends down and to the right into the iliac fossa.

These pouches may have no relation to the vestigial folds and pouches found commonly in most bodies, thus in a case of the author's of left paraduodenal hernia, the inferior mesenteric vein opened into the superior mesenteric vein and not into the splenic, while the paraduodenal pouch was present inside the large sac thus formed by the abnormal relation of the veins.

(2) The intersigmoid fossa has its opening below the sigmoid colon, and as it enlarges to admit the intestine extends upwards.

(3) There are several fossæ about the cæcum and appendix, the most important of which is the retrocolic, the mouth of which is behind the cæcum, and the sac of which extends up behind the ascending colon. With

the exception of the left paraduodenal, itself not very common, all these
herniæ are rare results caused by the snaring of a loop of intestine in a
fossa.

In all the above-mentioned conditions the loop of gut passes through a
narrow strait, and is there compressed. The blood-supply is blocked more
or less completely, and the loop becomes distended with gas, the wall
becomes œdematous and inflamed and finally gangrenous unless relieved by
operation or unless the loop slips out of the snare, which is not usual. When
a loop of intestine has slipped under a band it often becomes twisted in

Fig. 64   Diagram of internal herniæ.   a, Right paraduodenal hernia, whose mouth
lies behind the superior mesenteric artery and in front of the aorta.   b, Left para-
duodenal hernia ; the mouth lies to the left of the duodenum and is arched over by
the inferior mesenteric vein.   c, Mesocolic hernia.

addition, which increases the strangulation : this minor degree of volvulus
is also found inside hernia sacs. The condition of the gut above and below
such an obstruction has already been described.

Signs. In case of snaring by bands there is usually a history of previous
inflammation in the abdomen, especially appendicitis, or operations. Cases
of snaring through apertures may give a history of injuries or operations.
In the case of internal herniæ previous history is often negative, but there
may be accounts of previous attacks of partial obstruction relieved by the
gut slipping back out of the hernial pouch. The signs in general are those
described above, the abdomen is usually flaccid and not tender for two or.

three days. When, however, the loop is very severely snared the distension and œdema of the affected loop may give rise to a palpable resonant tumour which fairly soon becomes tender from the onset of peritonitis. Such tumours are not common, and most usually occur in the right iliac fossa or rising out of the pelvis (since bands are more common in these situations). Should the tumour be high up in the abdomen and to the left, the presence of a left paraduodeneal hernia may be suspected ; in other situations the strangulation may be due to bands, apertures, or internal herniæ. In most instances, however, the variety and site of obstruction remain unknown until the abdomen is opened.

(b) ACUTE STENOSIS, KINKING, OR STRICTURE OF THE GUT. This is a less common condition than the last described, and is caused in various ways, the effect being that the gut is sharply obstructed at some point, as regards its lumen, the blood-supply being unaffected except for the pressure of the band on the gut. The adhesions leading to this class of case more often produce chronic obstruction, and are as follows :

(1) Bands passing across the gut from the mesentery to the parietes, bow-stringing the gut as it lies under or hangs over them.

(2) A diverticulum or band attached to the free edge of the gut and to the parietes may by its traction sharply kink the gut, thus causing obstruction.

(3) The contraction of adhesions across a loop may bend this acutely at the angle of flexure, so causing obstruction.

There is usually in these cases some twisting of the gut affected, i.e. a partial volvulus, which renders the obstruction more complete.

(4) Matting of several loops of intestine by adhesions causing several kinks, no single one of which is very sharp, may together cause obstruction. The results are that grave pressure only acts on a small part of the affected gut, and so extensive gangrene is less likely to occur and resection of a large length of intestine is less often needed than in the former group. The signs are similar to those described above, and in these cases no tumour will be found.

(c) VOLVULUS. By this is implied a twisting of some part of the gut, most usually affecting a loop, when the twist is about the axis of the loop ; less often the gut may be twisted about its own axis. Various portions may be affected, including small diverticula. Thus the appendix may be twisted, and this is one of the causes of acute appendicitis, but seldom leads to intestinal obstruction except the dynamic form due to peritonitis. Volvulus of a Meckel's diverticulum may lead not only to inflammation and gangrene of the diverticulum itself, but also to kinking of the small intestine at the site of the diverticulum and so to obstruction of the lumen.

More commonly, however, the twisting occurs in a long loop of gut with a narrow pedicle, such as the sigmoid, cæcum, or more or less of the small intestine. Such loops may be twisted about their own axes or about other suitable coils of intestine. Volvulus is hardly possible if the mesenterry be of normal length as compared to the width of its attachment to the

abdominal wall. To twist easily a loop must be long and with a narrow base. Thus in a case of volvulus of the sigmoid we have found the mesentery to be over a foot long with a pedicle not more than two inches wide, the length of intestine involved being at least two and a half feet. The actual twisting is no doubt due to the alterations of fæces, flatus in the loop of gut, and the motion of the wall of the latter.

The results of volvulus are sudden blocking of the lumen of the gut and also cutting off of the blood-supply ; the latter is the more urgent condition and explains the distinctive signs of volvulus. The affected coil of intestine becomes hugely distended with gas, and being in most instances a portion of large size to commence with, very soon assumes enormous proportions, causing very rapid and obvious tympanitic distension of the abdomen. The mere size of the distended loop of gut renders the abdomen tense and rigid, and these properties are increased by inflammation of the peritoneal surface of the affected gut owing to the grave affection of the blood-supply, which soon leads to gangrene. In the earlier stages the coil may become untwisted, with relief of symptoms, and some patients have a history

Fig. 65. Volvulus or twisting of a loop of intestine at its mesenteric attachment.

of several minor attacks of similar nature before the one which brings them to the surgeon.

Diagnosis. The general signs are similar to other forms of obstructive ileus, but vomiting is usually a late sign owing to the block being so low in the bowel (volvulus is most commonly of the sigmoid). On the other hand, the rapidly increasing distension and tympanites are very notable, for these are so rapid that the abdomen may be found markedly increased in size if measured from hour to hour. The rapid peritonitis and incipient gangrene lead to early rigidity and tenderness of the belly. Another interesting sign we have noted in one instance was great œdema of the whole wall of the rectum as far as it was palpable, doubtless owing to blocking of the inferior mesenteric vein in the process of twisting. These cases suggest a perforative peritonitis when the initial rigidity of the latter has passed into distension, but the absence of early rigidity before distension develops will distinguish volvulus if the case is seen from the onset. Great disten-

sion, then, is the characteristic feature of volvulus; the distended sigmoid may in some instances attain a diameter of four to five inches.

(*d*) INTUSSUSCEPTION. In this affection a portion of the intestine is telescoped or invaginated into the part immediately below. The result of this is to diminish the calibre of the gut and to interfere to a greater or less extent with the blood-supply of the part intussuscepted. The process of intussusception is almost without exception in the downward direction, *i.e.* along the course of the peristaltic movements, the upper part being invaginated into the lower, or rather drawn down into the latter, since it must be insisted that it is the outer part of the intussusception which swallows the upper part and not that the upper works its way inside or
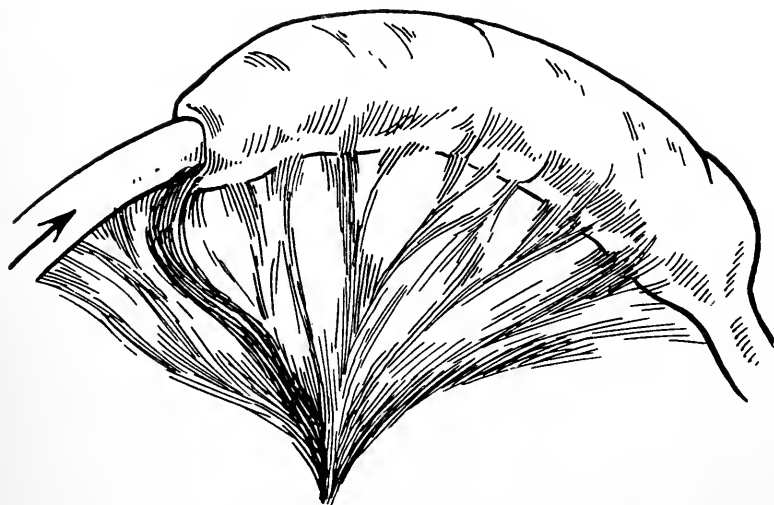
FIG. 66. Intussusception.

falls into the lower; the apex of the intussusception always remains the same part of the gut.

Viewed in section an intussusception consists of three layers : (1) the outer or receiving, called the *intussuscipiens*, which is the active part in producing and maintaining the invagination ; (2) the returning layer ; and (3) the entering layer. The two latter inner layers are together called the *intussusceptum*, being the part which is swallowed by the outer active layer. The intussusceptum travels down the alimentary canal propelled by the movements of the intussuscipiens, and may ultimately protrude at the anus. As the intussusception grows the outer receiving layer gradually passes inside and forms part of the returning layer.

The gut, however, is not a mere tube : in addition there are the mesentery and blood-vessels attached to one border of the intestine, and it is to the effect of the intussusception on the latter that the grave results of the affection are due. The traction of the stretched mesentery delays the downward passage of gut on that side and bends the swelling so that a sausage-shaped tumour results. In addition the pull of the mesentery

distorts the aperture at the apex of the intussusceptum, rendering it slit-
like instead of circular, and consequently more readily occluded. So much
for the action of the mesentery on the intussusception ; the latter has in
turn its effect on the vessels of the mesentery, which are bent and com-
pressed as they enter and return from the tumour, and hence there is inter-
ference with the blood-supply of the intussusceptum, leading to œdema,
inflammation, and finally gangrene of the latter. It is chiefly in respect
of the effect on the blood-supply that acute and chronic intussusceptions
differ. The inflammation of the peritoneum covering the entering and
returning layers leads to adhesions between these, which may assist in
making reduction of the intussusception difficult or impossible.

   Causes and Pathology. The causes of this strange affection have been
for long a subject for discussion, and even now are in many instances uncer-
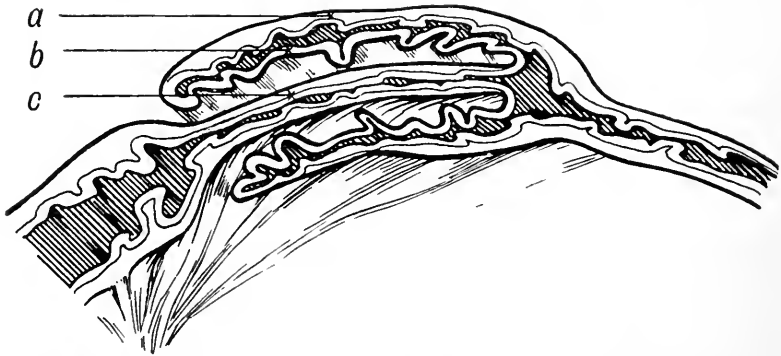
FIG. 67. Section of Intussusception. *a*, Receiving layer or intussuscipiens.
b, Returning layer ; *c*, Entering layer—together form the intussusception.
(The peritoneum is indicated by a thick line.)

tain. Irregular peristalsis has been assumed as a cause, and it is stated
that the condition has been produced experimentally by stimulation of
the gut, but this has not often proved successful ; while a history of pre-
ceding intestinal disturbance is only found in about a tenth of the cases
published.

   The most assured cause which is at all common is the projection of
some polypoid mass into the interior of the intestine. Such a protrusion
is forced along the intestine by peristalsis, and drags after it the portion
of gut from which it takes origin into the part below, and thus invagination
is started. That this may be the cause is proved by finding such a polypoid
mass at the apex of the intussusception, as has been noted in many cases.
Of such polypoid excrescences adenomas, cysts, lipomas, cancers, extrava-
sations of blood in Henoch's purpura (Lett), and above all congested Peyer's
patches are found ; while a Meckel's diverticulum, if invaginated, forms
a similar polypoid projection and acts in the same manner.   Local paralysis
may sometimes be a cause, as shown by finding the piece of intestine which
has previously been snared in a partial or Richter's hernia at the apex of
an intussusception (possibly such an area of gut was congested and swollen,

thus acting like a polypus). In all probability the commonest cause is a congested Peyer's patch, which projects as a polypus into the interior of the intestine. The reasons in favour of this view are :

(a) That intussusceptions are most common in infants, 75 per cent. being under a year old, and in these small subjects the lymphoid system, and with it the Peyer's patches, are larger than in older subjects.

(b) The most common intussusceptions in infants are those in the neighbourhood of the ileo-cæcal junction, where the lymphoid tissue is most abundant.

(c) After reducing an intussusception an enlarged polypoid mass, which is probably a congested Peyer's patch, can often be felt or definitely demonstrated post-mortem where the patient succumbs.

Mention has been made already of the curved shape of the tumour due to the drag of the mesentery, the slit-like aperture at the apex of the intussusceptum, and that portion of the gut which forms the apex remains in this situation with one exception, which will be mentioned later. A few more points demand notice. The outer layer is smooth and stretched over the intussusceptum, of which the returning layer is rugose and puckered from being stuffed into the position which it occupies ; the entering layer, again, is straight and stretched.

The effect on the blood-vessels of the mesentery is very variable ; the blood-supply may be cut off from the intussusceptum after a few hours or may not be much affected after days or weeks. When the blood-supply of the intussusceptum is rapidly cut off, œdema and inflammation of this results ; the entering and returning layers become glued together, rendering reduction difficult or impossible ; finally gangrene sets in, usually causing diffuse peritonitis and death. Very rarely the intussusceptum sloughs off and the lumen of the gut is restored, cure resulting. Where interference with the blood-supply is slight the condition will be chronic and associated with partial blocking of the intestinal lumen, or, in other words, is a variety of chronic obstruction. Not infrequently the lumen of the inner layer (entering layer) is blocked, although the blood-supply is not greatly interfered with ; in such cases the condition, although coming on acutely, is much less severe than in the ordinary acute cases, and reduction is easy after several days, while in the truly acute condition reduction is seldom possible after the intussusception has lasted three days.

Multiplicity. In rare instances two or more intussusceptions may occur at different parts of the intestinal tract. A more common condition is for the intussusception to be doubly invaginated. This is especially likely to happen in the region of the ileocæcal valve, as will be explained later. The second fold of the double intussusception is usually similar in direction to the first, but may be folded over in the reverse direction so that at first sight the intussusception appears to be ascending, and the reduction of such intussusceptions is rather startling, as when the place where this over-folding is reached in reducing the tumour, the latter suddenly seems to come in half.

Recurrence after reduction occurs in about 1 or 2 per cent. of cases.

Varieties. Following Wallace, this form of intestinal obstruction may be divided into : (1) enteric, where the small gut alone is involved ; (2) the enterocolic, where the large and small gut both take part, *i.e.* the affection is in the region of the ileocæcal valve ; (3) the pure colic.
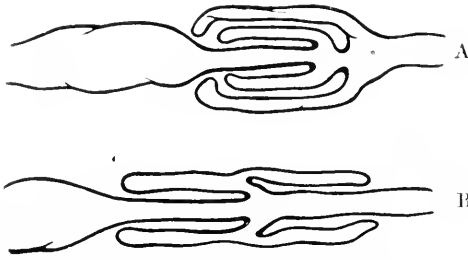
Fig. 68. A, Double intussusception. B, Double intussusception with the outer part reversed.

Fig. 69. Showing how an œdematous Peyer's patch at the ileocæcal valve may initiate an ileocæcal intussusception.

Both the pure enteric and pure colic forms are uncommon, found more often in adults than children, and form about 7 per cent. each of all cases.

The enterocolic are important in point of numbers, forming over 80 per cent. of all cases and being one of the commonest forms of acute intes-
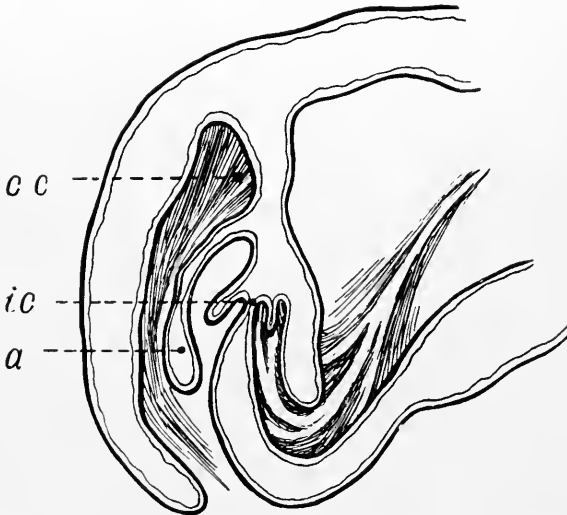
Fig. 70. Section of ileocæcal intussusception, showing how the vessels of the mesentery partially anchor the ileocæcal valve (*ic*) and allow the caput cæci (*cc*) to become the leading part of the intussusception. *a*, The appendix.

tinal obstruction. There are several subdivisions of this type. Probably in all cases the intussusception arises in the small gut, but may commence so close to the ileocæcal valve that the latter appears to be the apex of the intussusceptum. Thus a congested Peyer's patch immediately above the valve may be drawn through, and being caught by the cæcum, travels down

the colon in company with the ileocæcal valve (Fig. 69). This class of case, where the ileocæcal valve is in front or appears to be so, is called the ileocæcal variety, and is the most common form of intussusception. In a considerable number of instances the caput cæci forms the actual apex of the intussusceptum, and after reduction is found to be very œdematous and dimpled from the outside. It does not follow that the caput was the starting-point of the invagination. Probably in these cases the ileocæcal valve is in front at first, but is restrained in its course by the drag of the mesentery, and the caput cæci, being more free to move, is gradually driven in front of the former (Fig. 70). In favour of this view is the fact that the caput cæci is only found at the apex where intussusception is of considerable length. The remainder of the conditions found in this region are the ileocolic (where the ileum is invaginated through the ileocæcal valve into the colon) and its congeners, including various double forms. It was formerly thought that in the ileocolic variety the ileum prolapsed for some distance through the ileocæcal valve, *i.e.* the condition was formed to begin with at the expense of the entering layer (an exception to the general rule of intussusceptions). But it is uncertain whether such a condition is possible, and there can be little doubt that the ileocolic form originates as an enteric intussusception fairly close to the valve, and it is the different results which may happen as the intussusceptum reaches the valve which give rise to all the following varieties, the names of which are somewhat cacophonous and which we have taken the liberty of modifying in some instances.

Starting with a pure enteric form near the ileocæcal valve (Fig. 71), when the apex meets the valve, one of two things may happen :

(1) The valve may resist the apex and the intussusceptum with the valve pass down the colon. In this manner a double intussusception is formed known as the (*a*) entero-ileocæcal, *i.e.* it is an ileocæcal containing inside an enteric intussusception (Fig. 72).

(2) The apex of the intussusceptum may penetrate the valve and pass down into the cæcum and colon.

Where the intussusceptum passes partially through the valve it is known as (*b*) partial ileocolic (or iliaca ileocolic) (Fig. 73). The intussusceptum may stick at this point and the intussusception continue from the valve, giving rise to another type of double intussusception, (*c*) the partial ileocolic-colic (iliaca ileocolic-colic) (Fig. 74). If the intussusceptum do not stick anywhere in the valve the latter passes over the former till all the small gut involved is through, when we have the (*d*) ileocolic type (Fig. 75), and if the condition precedes it is at the expense of the colon and is called ileocolic-colic (Fig. 76).

The result then depends on the behaviour of the intussusceptum at the valve. If the latter be passed we find the partial ileocolic, which may pass on into the ileocolic or the double partial ileocolic-colic, while the ileocolic, if continued, becomes the ileocolic-colic. Should the intussusceptum be stopped at the valve the process becomes double or entero-ileocæcal.

In rare instances the appendix is invaginated and forms the apex of the intussusceptum.

Diagnosis of Acute Intussusception. As in other varieties of acute obstruction, the onset is sudden with vomiting and pain; the latter is
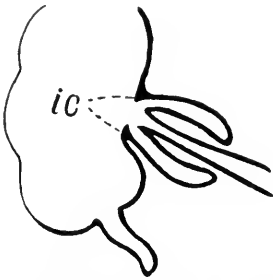
FIG. 71. Enteric intussusception which has reached the ileocæcal valve.
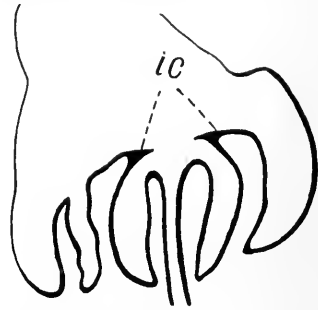
FIG. 72. Entero-ileocaecal intus susception.

FIG. 73 Enteric intussusception passing the valve (partial ileocolic intussusception).

FIG. 74. Partial ileocolic-colic.

FIG. 75. Complete ileocolic intussusception.

FIG. 76. Ileocolic-colic intussusception.

intermittent, *i.e.* a colic, with intervals of remission, during which the baby (the usual patient) lies quite placid. The appearance of these infants is characteristic: they are generally well nourished, often being breast-fed, but with marked abdominal facies, lying placid and rather apathetic

(from shock) except when the attacks of colic cause the legs to be drawn up and the patient screams with pain. Constipation is absolute shortly after the onset as regards fæces and flatus, but there may be notable tenesmus with the passage of blood-stained mucus, which is also found on the finger if the rectum be examined (as should always be done). The absence of fæcal matter in the rectum and the presence of blood-stained slime is almost pathognomonic, and where fæcal or green material is found on the examining finger the condition is usually one of colitis. We have, however, in one or two instances found green material in the rectum in the presence of an intussusception. Shock is marked from the first and vomiting is copious early but less marked later, rarely becoming fæcal. On abdominal examination a sausage-shaped tumour can nearly always be felt, usually in the course of the descending, less often in that of the transverse colon.

A little practice is needed to distinguish the tumour from the left rectus or the lower border of the liver in a well-nourished infant. Where there is distension of the intestine above the obstruction, *i.e.* after two days or so, the tumour is less easy to feel. Rectal examination may reveal the lower end of the intussusceptum, feeling rather like the cervix uteri in respect of the slit-like opening in its apex. On the examining finger will be noted blood and mucus. The presence of a tumour, felt through the rectal wall, is less certain ; this may be an intussusception, but unless the slit-like apex be felt the condition may be closely mimicked by an iliac kidney (p. 511, Fig. 175 B), a misplaced spleen or tuberculous glands. The general aspect of the patient and rectal examination will as a rule indicate the need for immediate laparotomy.

(e) IMPACTION OF FOREIGN BODIES. Of these gall-stones are the most important. Fæces and other solid bodies such as intestinal concretions, whether the result of food (*e.g.* avenoliths from oatmeal) or from medicine (magnesium salts), may have the same results, but seldom come into this category as they only become impacted in the large intestine and therefore cause chronic constipation, which may, however, later become acute.

Gall-stone obstruction usually occurs in females of middle or old age. A stone large enough to obstruct the lumen of the intestine cannot pass down the bile-ducts, and in practically all cases has ulcerated through from the gall-bladder to the duodenum, for if it ulcerates its way through into the colon it is unlikely to cause blocking of the larger lumen of this portion of the intestine.

Signs. Since the blockage is only of the lumen and the blood-supply of the gut is unaffected, there is but little shock at the onset, but as the obstruction is usually high up the small intestine vomiting is a pronounced feature. When found at operation these stones are usually in the lower ileum, but at the commencement of the attack are probably much higher up, and the stone passes down during the attacks, causing mitigation of the symptoms at intervals. Fæces and flatus are passed at times, but the signs of obstruction usually shortly return with increased severity. It is this intermittence of symptoms which renders these cases so insidious and

fatal, as the practitioner is tempted to dangerous procrastination. thinking that the attack has passed off, while in reality the stone has only passed a little lower down and becomes impacted again. Vomiting in these cases rapidly becomes fæcal. Sudden attacks with obstructive symptoms coming on in middle-aged females with a previous history of dyspepsia of some standing, especially if there be also a history of colic or jaundice, must be regarded with grave suspicion even if mitigated after a short time, and if vomiting persist the likelihood of the condition being due to obstruction of the small intestine with a large gall-stone is considerable even if shock be slight and constipation incomplete. In such cases it is wise to explore before the patient's condition becomes grave, as the death-rate for this affection at present is much too high. Other solid bodies, including Murphy's buttons, may produce a similar affection, and in the case of the latter there is no excuse for not knowing the cause of the trouble.

(*f*) ILEUS FROM MESENTERIC THROMBOSIS OR EMBOLISM. This affects the superior mesenteric artery or its branches, and as the anastomosis of its branches is not at all free it results that gangrene of the greater part of the gut supplied by the occluded vessels shortly ensues. The mesenteric arteries may be embolised by detached portions of vegetations from the valves of the heart or portions of atheroma of the aorta ; in other instances the veins may be affected by infective spreading thrombosis arising from some focus in the intestine. Thrombosis also follows on severe injuries of the abdomen or from snaring of gut in herniæ or under bands, twisting in volvulus or invagination in intussusception ; the latter conditions have been described already, and we refer here to blocking of the blood-vessels without blocking of the lumen of the gut.

The signs of mesenteric thrombosis are very similar to those of other forms of ileus, viz. shock, vomiting and constipation, but the latter is not absolute at first, and there may be a discharge of tarry, altered blood per rectum, of considerable amount where the amount of gut, the vessels of which are thrombosed, is extensive. There is also great tympanitic distension of the abdomen, since cutting off the blood-supply causes great dilatation of the affected intestine with gas. Peritonitis comes on rapidly, as shown by tenderness and rigidity. The condition very closely resembles that found with volvulus, except that the discharge of altered blood from the rectum and the presence of valvular disease of the heart may put the surgeon on the right track. At operation the peritoneal cavity is filled with blood-stained fluid and the affected intestine is dilated, congested, and the vessels manifestly thrombosed, while no other condition, such as a snaring band, is found to account for the condition.

(*g*) ILEUS DEVELOPING IN THE COURSE OF CHRONIC OBSTRUCTION. This forms a common and important group and should be less common, since we ought never to allow a case of chronic obstruction to become acute, as the operative mortality is at once enormously increased.

That ileus has supervened in these cases is shown by :

(1) The pain, which is intermittent in chronic cases, becomes constant.

(2) The distension, which comes and goes in a case of chronic obstruction, becomes permanent and constantly increases.

(3) The vomiting, which was occasional, becomes more urgent and finally fæcal.

(4) The constipation, which at first referred to fæces only, becomes absolute to flatus as well.

(5) Signs of shock appear, viz. rising pulse-rate, drawn face, cold extremities. The onset of ileus in these cases is often gradual, and it is often not easy to say if ileus has actually begun or is merely threatened.

The varieties of chronic obstruction will be discussed later, together with the diagnosis, which is most important, since if operation be undertaken before ileus has developed the prognosis is far better.

TREATMENT OF OBSTRUCTIVE ILEUS. We have now considered the diagnosis of ileus in general and of the several varieties as far as possible without opening the abdomen. The initial treatment is the same for all cases, viz. opening the abdomen and exploring, with few exceptions, to be mentioned later, viz. where in cases of ileus supervening on chronic obstruction (*e.g.* impacted fæces) it may be possible to relieve the obstruction from the rectum.

A few words on the examination of a case of ileus will not be out of place here, since an accurate recognition of the state of affairs inside the abdomen and the condition of the patient to stand operations of varying magnitude is useful and may save time later on, under circumstances where saving of time may mean the saving of life.

(1) Severe shock, as evidenced by small rapid pulse, pinched face, and cold extremities, may mean that the time available for operation is short, and it may be necessary to content oneself with some minor measure, such as draining a loop of gut, rather than spending time over much suturing, as may be necessitated by resection, &c.

(2) Pain tends to be constant where a loop of gut is snared but intermittent where it is simply blocked.

(3) Copious early vomiting implies obstruction of the small intestine high up, and fæcal vomiting is earlier in such cases.

(4) Constipation may not be absolute if only part of the circumference of the gut is blocked. Moreover, the gut below the block may empty its contents per rectum in the early stages. The inability to pass flatus though desiring to do so is an important feature in these cases.

Abdominal Examination. In most early cases the abdomen moves well and is not distended or tender. Early distension, tenderness, and rigidity point to volvulus or mesenteric thrombosis ; after three days or so to peritonitis from any form of obstruction.

Local distension of the intestine will only help to show the site of obstruction in some instances of ileus developing on chronic obstruction. Thus the colon may be seen distended in the flanks where there is obstruction in the sigmoid, while if the block is in the cæcal region there will be distension of the small intestine, showing the " organ-pipe pattern."

Tumours are observed under different conditions. The " sausage-like tumour " of intussusception is seldom absent, and various resonant tumours due to snaring of loops of gut, which becomes distended and œdematous, are sometimes found. Such a resonant tumour in the lower abdomen suggests snaring under a band, through an aperture, or, rarely, an internal hernia, while a similar tumour in the upper abdomen may be a left para-duodenal hernia. Occasionally foreign bodies such as gall-stones or malig-nant strictures may be felt through the abdominal wall.

The hernial apertures, both ordinary and extraordinary, must be care-fully examined in all cases of ileus of the obstructive type. Thus a small femoral hernia in a fat woman may not be at all obvious unless special examination be made, and is much better treated by herniotomy at its site than by laparotomy and hunting inside the peritoneal cavity. In urgent cases the proper line of attack may just turn the scale between victory and defeat.

Examination of the rectum should never be omitted in these cases, since very valuable information can thus be acquired. The site of obstruction may thus be absolutely located, as in cancer of the rectum, or various tumours blocking the rectum may be felt, including appendix-abscesses, pelvic cellulitis and peritonitis, impacted foreign bodies, fæces, intussusceptions. Finally, the substance found on the examining finger may throw light on the diagnosis, as in the case of blood and mucus found below an intussus-ception or the altered blood in mesenteric thrombosis.

Turning now to treatment, laparotomy is essential in all cases except where the obstruction is caused by fæces or foreign bodies impacted in the rectum, from which they may be extracted manually, or in cases of cancerous and other stenosis of the rectum, where left inguinal colostomy should be done. The abdomen is opened (for choice under intraspinal anæsthesia) by a paramedial incision, retracting the rectus outwards ; this incision is usually below the umbilicus, as most causes of obstruction are situated in the lower abdomen and pelvis, but may be carried upwards, while in some instances, e.g. intussusception, the incision is made with its centre at the umbilicus. In adults the incision should be large enough to admit the hand of the operator, but in infants it is only necessary that three fingers be admitted, as the smaller abdomen can thus be fully explored with less damage to the contents than if the whole hand be introduced. In very severe, almost moribund, cases it will be occasionally right to make a smaller incision under local anæsthesia, pull up the first distended loop of gut which presents, and drain by inserting a Paul's tube. This plan should be only reserved for the very worst cases as its success is most uncertain : should a loop of gut be snared, it must almost certainly fail from the resulting gangrene, but may be successful if done above an acute kink or an impacted foreign body. Of course, a second operation will be necessary in four to ten days to relieve the cause of obstruction and close the aperture in the gut. In ordinary cases the first thing after opening is to ascertain the seat of the obstruction, and the following routine should be employed :

(1) Examine the cæcum, and if this be found distended the block is in the large intestine lower down.

(2) If the cæcum be full, examine the sigmoid ; if this be distended, it must be traced down to the upper rectum, where the constriction will be found, possibly out of reach of the finger in the rectum : a left inguinal colostomy is done, and the mobility of the growth and presence of secondaries in glands and liver noted with a view to excision later.

(3) If the sigmoid be empty the large intestine must be traced round till the obstruction is found.

(4) Where the cæcum is empty, or if on opening the abdomen contracted as well as distended small intestine be found, there is no doubt that the obstruction is in the small intestine and lies between the empty and distended coils ; in such cases there is no need to examine the cæcum. To find the site of obstruction in the small intestine may not be an easy matter, and before attempting to do this in cases where there is great distension the intestine should be emptied of flatus and fæcal content. We find this most effectively done with a trochar and cannula of about one-eighth of an inch bore and so long as to carry the fæcal efflux well clear of the abdomen. Moynihan's glass tube is unnecessary and at best a clumsy weapon : there is no need to have a very large-bore trochar as in these cases the fæcal material is thin liquid and gas. Tapping the gut in three places and judicious milking will render further operation much easier ; the trochar puncture is closed with purse-string sutures inserted before the trochar and tightened after its removal. To search for obstruction of the small intestine, the places where it is likely to occur should be examined, viz. the right iliac fossa and pelvis, where bands are common. The inguinal femoral and obturator apertures and rings are examined for herniæ which have been missed from outside, then the umbilical region searched for hernia or Meckel's diverticulum, and the commencement of the jejunum and the sigmoid regions examined for internal herniæ. Failing any discovery so far, the collapsed small intestine should be traced to the site of obstruction. This is better than tracing the distended gut downwards, being easier and less damaging to the gut handled, since the inflamed, congested, and distended gut above the site of obstruction is more easily injured by excessive handling than the comparatively normal gut below and the contracted gut is more easily returned to the abdomen. Where there is no collapsed gut visible it may be found by pulling up the cæcum and tracing upwards from this point, for the lower ileum must be empty in these cases. If this plan and that of emptying the most distended coils with trochar be adopted there will be no necessity of eviscerating the patient to find the site of obstruction. Another plan where in difficulties is to insert a Paul's tube into the largest coil and hope for the best, but this course is only advisable where the patient's condition suddenly becomes much worse, as its success is problematical.

Having found the cause of obstruction, it is dealt with as described under the treatment of Special Forms of Obstruction. The main points to be settled are whether relief of the obstruction is sufficient or whether the

gut is so damaged that part of it needs resecting, or whether the latter should be drained, and if so, whether it will suffice to remove the contents on the operating-table with a trochar or whether a Paul's tube must be left in for some days (colostomy). The abdomen must not be closed while the intestine is still distended or atony will follow and paralytic ileus closes the scene. On the other hand, if the gut be but moderately distended above the block and begins to empty itself into the part below when the block is removed there is no need to drain the intestine and risk fæcal contamination of the peritoneum. Where the obstruction is remedied and the gut is much distended the latter should be emptied with a trochar as advised above, and in the case of the small intestine two or three punctures will be needed to accomplish this effectively, but the colon can be emptied of liquid contents through one puncture in the cæcum.

Evacuation of the contents of the intestine is urgently needed where there is any difficulty of returning them to the abdomen at the close of operation. Where resection is practised the gut above the obstruction can be effectively drained by allowing the resected end, unclamped, to hang over the edge of the table (Barker). When the contents of the small intestine have been evacuated the puncture should be closed, because if the gut be drained outside and the obstruction be high up there is so much loss of absorbent surface that the patient suffers from malnutrition and rapidly goes down-hill. Drainage of the large intestine on the surface (colostomy) is excellent before proceeding to more radical measures, but if the patient's condition be not too grave a lateral anastomosis to " short-circuit " the obstruction may be better practice.

Mention has already been made of the advisability of intraspinal anæsthesia for these cases : where general anæsthesia is used there is considerable risk of the copious vomit being inhaled, with fatal results ; hence it is well to pass a stomach-tube before commencing the operation under general anæsthesia and syphon off the contents of the stomach.

TREATMENT OF SPECIAL FORMS OF OBSTRUCTION. (1) *Bands and Cords.* Having found the site of obstruction, the band is clamped and divided, the ends of the band being ligatured : should the band prove to be the appendix or a Meckel's diverticulum it should be tied off close to its origin from the intestine and the stump invaginated with a peritoneal layer of sutures.

(2) *Strangulation through an Aperture.* The aperture must be enlarged by incision to permit of reduction, taking care while doing this to avoid important structures such as vessels or bowel, and remembering that vessels when strained tight round the loop of gut may be void of blood and closely resemble folds of peritoneum.

(3) *Internal Herniæ.* There may be great difficulty in avoiding injury to surroundings while enlarging the neck of the sac by incision thus :

(*a*) In the case of herniæ through the foramen of Winslow the neck of the strangulated gut is surrounded by the vena cava, portal vein, hepatic artery, and liver. In this case the liver is the only part which can be safely

incised to enlarge the aperture. and after reduction the incision may be plugged with gauze.

(*b*) In the case of left paraduodenal hernia the inferior mesenteric vein surrounds most of the neck of the sac, in the right variety the superior mesenteric artery and aorta, the duodenum forming the rest of the ring in both conditions. Hence much care is needed to enlarge the opening in these cases.

(4) Acute kinking by a band is treated by division of the band, as before. In all cases where adhesions are divided an attempt is made to cover the raw surface lest new adhesions form, causing obstruction later. After relieving the obstruction the gut must be examined locally to see if it is viable and will be able to continue its functions. This may not always be an easy matter. Where it is greyish-green and stinking removal is obvious, but where merely black with shiny, peritoneal surface and some feeling of elasticity on palpation, particularly if peristalsis returns after the block has been removed, it may usually be left. But where it is black and flabby, even if the peritoneal coat be intact, and the odour is commencing to be mouldy, resection of the loop is indicated. Special attention should be directed to the part where the pressure has been greatest, viz. at the neck of the sac or site of the band or aperture, as, although the bulk of the strangled loop may be viable, there will sometimes be found at this situation a small grey, gangrenous patch from pressure-necrosis.

Where such a patch of gangrene is small and not extending more than one-third of the circumference of the gut it may be invaginated with a peritoneal suture so that perforation cannot occur, but if more than this amount is gangrenous it is better to resect the affected part.

Resection of Bowel for Gangrene due to Obstructive Ileus. The surgeon must decide how much gut will need resection ; this includes the part unlikely to recover. Inflamed and œdematous intestine will often recover well and stand suturing admirably, but if its tonus be lacking and it feels flabby it must come away. Intestinal clamps are placed a short distance below the part to be removed and the mesentery of the part involved secured with one or more ligatures some little way from the intestinal border of the latter, as this involves fewer ligatures and saves time. The gut is crushed between the clamps, tied, and divided above this ligature. Next the gut is cut away from the mesentery as far as the part to be resected extends, and the part thus freed is allowed to hang over the edge of the operating-table ; the clamp is removed and the upper, distended gut drains freely into a suitable receptable while the lower end is being treated. Any vessels not secured in the cut mesentery are tied and the stump of the lower end of intestine oversewn with purse-string or otherwise to cover in the ligated end. By this time a good deal of fæces and flatus will have drained from the upper free end, and the latter is treated in a similar manner, being crushed above the gangrenous part, tied, and the latter cut away, and then the stump invaginated. It now only remains to join the two closed ends of the upper and lower segments by a lateral anastomosis and sew together the mesentery where the gut has been excised ; the latter is
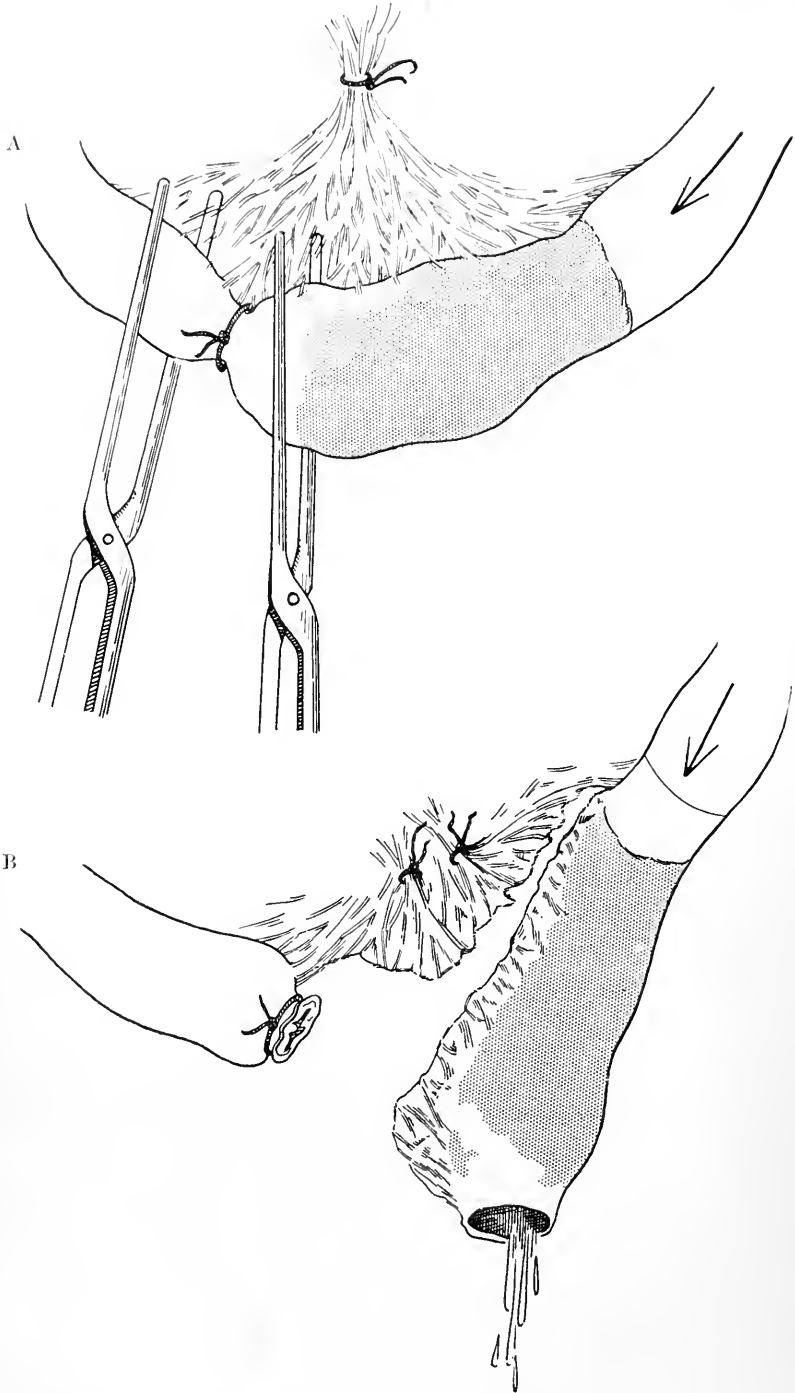
Fig. 77. Excision of gangrenous intestine. A. Mesentery tied off, and gut clamped and tied below the gangrenous area. B, Gut divided below the gangrenous part and cut away from its mesentery allowed to force fæcal content into a receiver, while the lower stump is being over-sewn.

an important step else a hole is left in the mesentery, a fertile source of obstruction in the future. Where the gut above and below the obstruction are of equal size (which is unusual) they may be united after the gangrenous part is removed by end-to-end anastomosis, which has the advantage of greater celerity. This plan is said to be followed sometimes by stenosis later ; we have found it feasible in but few instances, but in these it answered admirably. The mesenteric border requires especial attention in inserting the sutures. Both end-to-end and lateral anastomosis are described in the chapter on General Abdominal Surgery (pp. 99–102). As much as eight or nine feet of small intestine have been removed with success on several occasions.

(5) *Volvulus*. The appearance on opening the abdomen is characteristic ; the hugely distended large intestine (the usual offender), vast and purple or black, resembles at first sight a twisted ovarian cyst, but the muscular
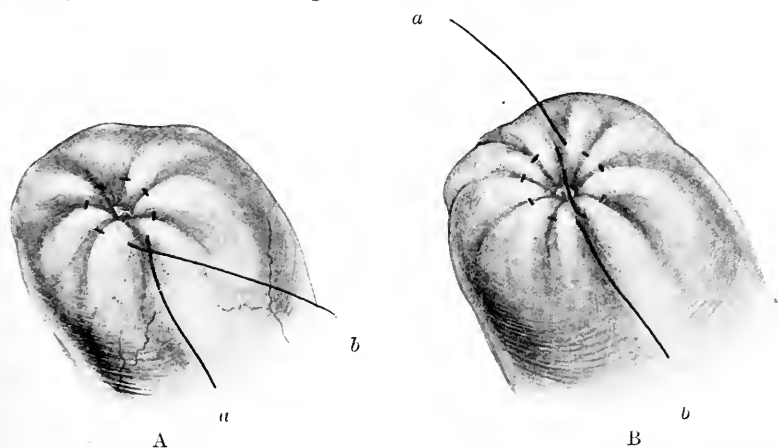
FIG. 78. A, Invagination of ligatured intestine or crushed intestine by a purse-string suture. B, Invagination by z sutures; the ends *a*, *b* are tied and pulled tight, invaginating the central part.

tæniæ and softness show the true nature of the tumour. Reduction of the volvulus is seldom possible till it is emptied ; nor is the latter a difficult matter, since the contents are mainly gas. A peritoneal purse-string suture is inserted and a trochar passed through this, the flatus evacuated, and the purse-string closes the gut again. The volvulus now hangs limp and can often be readily untwisted : where there is much fluid fæces present this may be removed in the case of sigmoid volvulus, after relieving excessive tension with the trochar as mentioned, by the passage of a long rectal tube. After the volvulus is reduced treatment varies ; excision of the redundant loop, followed by lateral anastomosis, is the ideal method, and we have found this answer well if the patient's condition is good and the volvulus is of the sigmoid.

Where the condition of the patient is grave but the volvulus is not gangrenous the latter is drained by tying in a Paul's tube (colostomy). Where the loop is gangrenous resection is essential, and following this, drainage for a time (colostomy) will be more successful than immediate

suture owing to the depressed condition of the patient and his inability to stand prolonged operations. Where the gangrene is very extensive and in the sigmoid there may not be enough intestine below to repair the breach, and a permanent colostomy will inevitably remain. Where the whole of the small intestine is twisted at its mesentery removal is out of the question and temporary drainage of one of the coils is the only possibility.

(6) *Intussusception.* Early laparotomy is again the counsel of wisdom, for although it is possible to reduce intussusceptions by pumping various fluids, including air, milk or water, up the rectum (indeed spontaneous reduction occasionally occurs), yet it is never possible to be absolutely certain that the last difficult piece is really reduced, and if this has not happened time must elapse before the surgeon can decide that insufflation has failed, and this time the patient cannot afford to lose. Seeing the difficulty one often meets with in reducing the last two inches of an intussus-
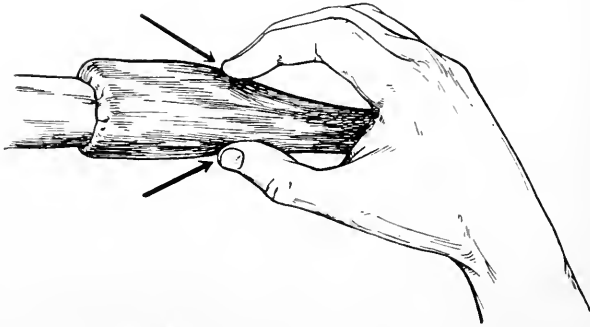
Fig. 79. Method of reducing an intussusception.

ception at operation, it is certain that rectal insufflation will fail in most cases, and the waste of time will considerably endanger the patient's life.

If the intussusception can be readily reduced so that the whole operation does not take more than fifteen minutes, practically all cases recover ; where reduction is difficult, so that the operation takes over twenty minutes, the prognosis becomes grave ; and where the intussusceptum is gangrenous and resection is essential, recoveries are quite rare : all of which facts point to the great importance of early diagnosis and operation, since the earlier operation takes place the greater the ease of reduction.

The abdomen is opened by a paramedial incision having its centre opposite the umbilicus. Three fingers are introduced and reduction commenced by milking the receiving layer over the apex of the intussusceptum, *i.e.* the apex is gently squeezed between the fingers and slips away from these through the receiving layer. The greater part can be reduced in this manner but the last two or three inches are more fixed, and the tumour, thus considerably reduced, should be brought outside the abdomen and firmer pressure made with the thumb and two fingers in a similar manner. No good results from pulling on the entering portion of the gut. As soon as reduction is complete no time is lost in closing the abdomen, but this should be done efficiently with, at any rate, a layer of interrupted sutures

securing the anterior layer of the rectus sheath, whatever plan be employed to close the remainder. Where the intussusception has passed low into the rectum it is necessary for an assistant to push it up with a finger in the rectum till the surgeon, working inside the abdomen, can get his fingers below the apex of the intussusceptum. Where the intussusception is irreducible or the intussusceptum gangrenous (conditions which often occur together) the outlook is bad, as few infants survive if more than simple reduction be necessary. The gangrenous part may be resected and the ends joined by end-to-end or lateral anastomosis, or simply excised and the two ends brought out and drained with Paul's tubes tied into them; or the intussusception may be brought out and a Paul's tube tied in above the obstruction, resection being done later when the patient's condition is improved by drainage. Successful results have been recorded by each method, but success is so rare that it is difficult to say which is really the best. We are inclined to advocate resection, followed by end-to-end anastomosis, having been successful with this plan. The above chiefly refers to intussusceptions in infants, which furnish by far the larger number of cases. In adults the methods of reduction are similar, but irreducible cases stand resection better, and there is more often some condition, such as a malignant polypus, which demands resection, though this should be done if possible at a second operation.

(7) *Obstruction from Foreign Bodies* (gall-stones). This occurs most often in the small intestine, and some search may be necessary before the block is found. The foreign body is removed by incising the gut along the anti-mesenteric border in a longitudinal direction and, after extraction, suturing the cut transversely to avoid any chance of stenosis later. Where the gut is much damaged at the site of blocking, the object should be pushed up or down so that the incision passes through a better part of the gut, but this may not be an easy matter where firm impaction has occurred. The intestine is carefully examined for local gangrene due to pressure, when oversewing or resection may be needed. Where there is much distension the gut above the obstruction should be well drained through the incision before the latter is closed.

(8) *Mesenteric Thrombosis.* In these cases a larger or smaller portion of the small intestine is in a state of incipient or actual gangrene, and the only prospect of saving life is to resect the gangrenous part. Where most of the small intestine is affected interference is useless, and the abdomen may be closed. Where only a small part is affected this may be excised, or if near the lower end of the small intestine the affected loop brought out and drainage made through this, the enterostomy being closed by a second operation.

(9) *Ileus supervening on Chronic Obstruction.* These cases are mostly due to cancer of the large intestine, and as the cause is steadily progressive the signs are also intensive, so that it may not be easy to say when the limit of chronic obstruction has passed and that of ileus begun : some of these cases deserve the title of subacute ileus, and treatment varies

with the severity of the clinical signs and on what is found inside the abdomen.

Thus where the patient is very ill with fæcal vomiting, great abdominal distension and small, rapid pulse, the block being in the large intestine, it is essential to relieve the distension of the gut by suitable colostomy above the obstruction, sigmoid colostomy for obstruction of the rectum and lower sigmoid, transverse colostomy for obstruction from this point up to the splenic flexure, right lumbar colostomy or cæcostomy for obstruction of the hepatic flexure and ascending colon, nothing being done to the obstruction itself till the urgent signs have passed off. Again, the case may be less urgent, vomiting perhaps moderate and not fæcal, distension not great and the pulse but slightly increased, and the general condition good. In such cases we may consider that ileus has commenced but is not yet severe (it may be noted that ileus from other causes always comes on suddenly, but in this type gradually).

In such a case we may treat the condition by lateral anastomosis where feasible, e.g. for obstruction of the upper part of the colon we may join the lower end of the ileum to the sigmoid flexure. Where the obstruction is too low down the large gut to admit of short-circuiting, colostomy will be needed, as before. In either case the growth may be examined, and if it appear removable this is done at a second operation, but never where any obstruction is present. Where such obstruction is due to band or kinks, these will be divided till the passage of fæces is assured and the abdomen closed, only draining the intestine where this is much distended.

To sum up, in all cases of obstructive ileus the surgeon has to decide :

(1) If the obstruction require immediate removal, as where it is causing actual or threatened gangrene of the gut, or if it be a solid body which cannot be removed per rectum.

(2) Whether any portion of the gut must of necessity be resected.

(3) Whether it is essential to drain the gut above the obstruction, and if so, whether it will suffice to drain it at operation and close the opening or whether drainage for some days by means of enterostomy or colostomy is indicated. Drainage of the former sort is advisable where there is much distension of the small gut, so that either there is difficulty in returning the intestines or the contents do not flow on readily after the obstruction has been relieved. Drainage by enterostomy is seldom advisable for small-gut obstruction but may be done where the block is low down.

Drainage with Paul's tube and colostomy is advisable in cases of obstruction of the large intestine where there is great distension, or in cases with but slight distension where shortcircuiting the obstruction by lateral anastomosis is impossible (see pp. 265–267).

Chronic Intestinal Obstruction ; Partial Obstruction. The latter would perhaps be the better term, as it is owing to the block of the gut being partial and often intermittent that the condition persists and may assume a chronic form.

Anatomically in cases of chronic obstruction, the latter is only to the

lumen of the gut, the interference with the blood-supply being negligible, and the obstruction of the lumen is partial or intermittent, since a complete block rapidly causes ileus. Fæces will be passed with increasing difficulty, and later there is difficulty with flatus as well, till complete obstruction or ileus sets in.

Signs. These present some similarity to those found with ileus but greatly mitigated and drawn out.

(*a*) *Shock* is not present, but instead a very gradual failure of the bodily powers.

(*b*) *Vomiting* is often absent till ileus supervenes, and when it occurs is not urgent and recurs at intervals of some duration (an increase in the frequency of vomiting suggests that the more acute stage is drawing near).

(*c*) *Constipation* is never absolute, and is often associated with loose stools or attacks of diarrhœa and passage of mucus per rectum. These attacks of diarrhœa are due to the irritation of hard, scybalous masses of fæces which collect above the obstruction, causing a catarrhal inflammation of the intestine and outpouring of mucus. The efflux of mucus may soften the fæces, which then pass the stenosis and the partial obstruction is relieved, only to recur again. In the lower part of the large intestine obstruction is often associated with tenesmus or desire to defæcate, the result being a passage of mucus and perhaps blood.

(*d*) *Pain* is intermittent, being in the form of colic, *i.e.* the expression of the intestinal muscular wall trying to overcome the block, and it is worse during the attacks of constipation, vomiting, and distension.

(*e*) *Distension* is intermittent, the abdomen rapidly swelling up and then becoming again flat, with passage of flatus.

(*f*) It is during these attacks of distension that *peristalsis of the intestine* above the obstruction is so readily seen through the abdominal wall, and it is often clear by the position and shape of the dilated mobile portion whether the colon, small gut, or stomach is affected. Visible peristalsis nearly always implies that chronic obstruction is present.

Attacks of pain, vomiting, and distension show that the condition is not far removed from ileus, which may come on at any moment, though as a rule these signs pass off and recur again several times before obstruction becomes absolute.

(*g*) A *tumour* may be felt in some instances of growth of the colon or of a chronic intussusception, while examination per rectum may reveal a growth or a mass of impacted fæces. As a whole the signs differ from those of acute obstruction in that they are intermittent, that shock is absent, and peritonitis does not occur except in cases of perforation of a stercoral ulcer above an obstruction.

Causes of Chronic Obstruction. These are many and may be divided as follows :

(1) Blocking from without the wall of the gut by bands, adhesions, tumours, &c.

(2) Stricture in the wall of the gut, including simple and malignant stenosis.

(3) Impacted fæces and foreign bodies.

(4) Chronic intussusception.

(5) Idiopathic dilatation of the colon.

(1) The after-effects of intra-abdominal inflammation are manifold in the way of bands and adhesions resulting from appendicitis, tuberculous peritonitis, &c. If the lumen only and not the blood-supply be affected, partial obstruction usually results. In some instances the band crosses the gut in one place, or several coils may be matted together, or the gut may be kinked. Pelvic peritonitis or cellulitis and tumours in the abdomen or pelvis may act in a similar manner. Lane's kinks and Jackson's membranes, &c., are discussed later under the ultra-chronic forms of obstruction.

(2) Strictures and stenosis of the wall of the gut have already been described, including simple fibrous stricture, the result of contraction of ulcers, hypertrophic stricture from tuberculosis and diverticulitis, stricture from cancer.

(3) Impacted fæces are a common cause of partial obstruction. The drying and impaction takes place in the lower part of the large intestine, and may be simply the result of prolonged constipation or accompany partial stenosis or be due to some irritative condition inimical to defæcation, such as an *anal fissure*. The fæces form one or more tumours, palpable from the abdomen or rectum. In the latter case the diagnosis is obvious, in the former the tumour has to be distinguished from other abdominal tumours. The position in the line of the colon, the fact that it occurs in middle-aged persons, usually females, that the tumours are mobile and can be indented by pressing firmly with the finger and altered in position and size and often removed by enemata, serves to make the diagnosis.

(4) Chronic intussusception resembles the acute type in its manner of formation, but the blood-supply is but slightly affected, so that œdema and inflammation are much less marked and gangrene does not occur except late. The condition may persist for months before becoming acute, is far more common in adults and old persons than in infants, and is often due to the presence of a malignant or other growth of a polypoid form which is dragged down by the peristalsis of the gut below and so starts the invagination.

The signs are like those of chronic obstruction in general, the passage of blood and mucus per rectum being specially noted, while a mobile abdominal tumour is present in many instances.

(5) *Idiopathic Dilatation of the Colon* (Hirschsprung's disease). This is found mostly in children and adolescents. The colon is greatly hypertrophied and dilated ; the patient presents the signs of very chronic obstruction with visible dilatation and peristalsis of the whole colon, which may be filled with an inspissated mass of ancient fæces of the consistency of mud or brown paper. The condition is probably due to various causes

which often escape observation, but blocking of the lower sigmoid or rectum of a partial nature and of congenital origin accounts for some instances. When neglected, acute obstruction will eventually follow, though this may take years.

DIAGNOSIS OF THE VARIETIES OF CHRONIC OBSTRUCTION. In the first place, obstruction of the small gut is to be distinguished from that of the colon by noting the character of the abdominal distension and of the peristalsis of the gut. Where the distension occupies the centre of the abdomen and the moving coils are many and small the block is at or above the cæcum; where the flanks are full and the peristalsis is of large coils the obstruction is low down in the colon, but the locality may be difficult to decide. The small intestine is usually affected by simple stenosis or matting of adhesions. The colon is far more often the site of chronic obstruction than the small intestine : in childhood idiopathic dilatation and congenital stenosis of the lower colon are likely causes; in later life cancer and impacted fæces are the commonest causes, but hypertrophic tuberculosis and diverticulitis account for some instances. Examination per rectum will reveal impacted fæces and strictures, innocent or cancerous, while the sigmoidoscope will carry the investigation a foot or so further from the anus. Finally, laparotomy is often needed before a diagnosis can be made.

Treatment of Chronic Obstruction of the Bowel. Operative measures are needed in most cases, but there are a few exceptions. Conditions amenable to non-operative treatment are : (1) fæcal impaction; (2) certain cases of chronic obstruction due to recent adhesions, which tend to become absorbed.

(1) Impacted fæces should, if possible, be extracted per rectum. When very hard they are softened with preliminary injections of warm olive oil followed by soap and water; then, with the help of a silver dessert-spoon under anæsthesia, many pounds may be extracted, and as the lower sigmoid and rectum are emptied more of the mass can be massaged down from the upper parts of the colon by abdominal manipulation. Some caution is, however, needed, as if stercoral ulcers be present and the wall of the gut thus weakened it may give way, with fatal results; consequently, where there are masses of long standing and great size in the upper colon it is better to trust to repeated enemata alone, and should these fail, to open the abdomen and extract the mass after incising the gut. Where fæcal impaction complicates a stenosis, operative measures will also be needed.

(2) Symptoms of chronic or partial obstruction not infrequently occur after abdominal operations for some form of peritonitis, *e.g.* appendicitis. In this type of case a careful watch should be kept for collections of pus in the pelvis or elsewhere, which should be opened when diagnosed; otherwise the treatment is confined to enemata and mild laxatives such as castor-oil, careful watch being kept, and if the signs become worse, opening the abdomen and dividing adhesions before the condition assumes the acute form.

Where the condition is not due to fæcal impaction or some recent subacute condition which may pass off, the abdomen should be opened as soon

as can conveniently be done, after a diagnosis is made. There is not the same urgent hurry as in obstructive ileus, but delays are dangerous as ileus may supervene at any moment, and this complication makes the patient's prospects of recovery far worse.

Treatment of Special Forms of Chronic Obstruction. (1) Where the affection is due to bands, adhesions, kinks, &c., the causal adhesions are divided if possible, and raw surfaces covered with peritoneum to prevent further adhesions. The appendix should be examined and removed if diseased, as this is one of the commonest causes of adhesions; tuberculous glands, &c., may also be removed. Where the matting by adhesions is very dense it may be impossible to divide these without injuring the intestine. In such cases we excise the part involved if only a few inches long, but where much of the small intestine is involved it is better to short-circuit the obstructed part by lateral anastomosis.

Where the large intestine is affected it may be necessary to perform colostomy above the obstruction.

(2) Stenosis of the intestine has been described under Cancer, Tuberculous Ulcer, and Diverticulitis. The affected part is excised and the ends joined, usually by lateral anastomosis. Where the stricture is malignant a considerable length of gut above and below the stricture is removed as well as the mesentery, and lymphatics are removed, while if innocent only enough is resected to obviate the obstruction, and the mesentery is divided near the gut.

(3) Treatment of fæcal impaction has been described already, being usually non-operative. Where fæces are much hardened it may be necessary to remove them by laparotomy. After this is done the gut is carefully inspected below the fæcal mass to see if there be not also some form of organic obstruction (stricture) as well which is amenable to operation.

(4) The treatment of chronic intussusception depends on the underlying cause. In children reduction, if possible, may suffice, but reduction may not be possible from the firmness of adhesions between the entering and returning layers.

(a) If much distension be present the gut should be drained by inserting a Paul's tube above the obstruction and resecting this at a second operation.

(b) Where the distension is not so great the intussusception may be excised and the continuity restored by lateral or end-to-end anastomosis. In adults, however, or where there is some suspicion that there is a malignant tumour causing the intussusception, a lateral anastomosis to short-circuit the obstruction should be done well away from the growth, and then after ten days the intussusception resected with a wide area of intestine, mesentery, and the lymphatic glands.

(c) Where the obstruction can be obviated with enemata so that there is no dilatation above, there is no reason why the intussusception should not be removed widely at once.

(5) Idiopathic dilatation of the colon should be treated at first by measures to empty the gut, first making sure that there is no partial obstruc-

tion in the rectum or sigmoid. Enemata, rectal washes, drugs to stimulate the tone of intestinal muscle, such as strychnine, atropin and laxatives, are used ; abdominal massage and exercises will also be useful.

Where these measures fail after several months' trial or the condition recurs readily or threatens to become acute, operative measures should be undertaken. Laparotomy is performed and the lower sigmoid and rectum examined for the presence of congenital twists or kinks, which should be rectified ; if these are not present the ileum should be divided at its lower end, the distal part closed, and the proximal end implanted laterally into the sigmoid. If this be not successful (it may happen that fæces remain dammed up in the large cul-de-sac formed by the cæcum, ascending, transverse, and descending colons) the above-mentioned cul-de-sac should be resected.

ULTRA-CHRONIC INTESTINAL OBSTRUCTION ; INTESTINAL STASIS. Under this heading it is convenient to group a number of conditions which agree in the fact that they tend to produce a slowing of the flow of intestinal contents through the gut and give rise to various pains and toxic phenomena, but differ from ordinary chronic obstruction in that the obstructive phenomena rarely advance beyond a certain point and the supervention of ileus is hardly known in these conditions. Several anatomical departures from the normal are found, some of which at times seem to be responsible for the symptoms complained of by the patient ; in other instances one must be somewhat sceptical at the pathological significance of the peritoneal and intestinal alterations. The anomalies in question are abnormal portions of peritoneum, " veils," " membranes, " adhesions," together with prolapse and dilatation of various portions of the intestine, especially cæcum and colon.

The primary cause of the " adhesions " is uncertain : the views most usually held are that they are (1) the result of abnormal development in the folding of the peritoneum as the cæcum travels from its primary to its final position, or (2) that they are the result of adhesions of which appendicitis forms the common starting-point ; but colitis, gall-bladder affection, gastric and duodenal ulcer doubtless account for some varieties. A third view is held by Lane, who considers that they are the result of the assumption of the erect position and the constant drag of the intestine on the mesentery, causing a crystallization or thickening of the latter with the bands, &c., which are found. The erect position is in some degree to blame for some of the abnormalities, such as prolapse of the stomach, colon, cæcum, &c., but the erect position alone is usually insufficient for this purpose and the full effect is only produced when an additional factor comes into play, and that is the pressure of corsets, which accounts for the preponderance of these conditions in women. It, however, does not seem well proven that visceroptosis can cause the formation of bands, &c., in the absence of inflammations or congenital abnormalities.

In addition to the conditions of definite ptosis affecting the liver, stomach, cæcum, colon (nephroptosis is described under Renal Affections), bands and veils are found in the following situations :

(*a*) About the gall-bladder, fixing the latter to the duodenum and transverse colon.

(*b*) Between the upper end of the ileum and transverse mesocolon.

(*c*) Between the lower end of the ileum and posterior peritoneum of the posterior abdominal wall.

(*d*) About the ascending colon and cæcum (Jackson's membrane). This is a thin gauze-like veil of peritoneum or adhesions covering the front of the ascending colon and cæcum, often continuous with the right edge of the great omentum and sometimes drawing the transverse colon towards the ascending colon so that the hepatic flexure becomes kinked or " angled."

(*e*) The splenic flexure may be " angled " by similar bands.

The clinical effects are diverse, and we may doubt whether these kinks and bands really account for the signs in all cases.

The general signs which are regarded as being due to auto-intoxication are loss of flesh, irregular pyrexia, weakness, staining and wrinkling of the skin, excessive sweating, headaches, impaired mental powers. These patients are generally spare, and visceroptosis is a marked feature. Dragging pain in the abdomen, relieved by assuming the supine position, and flatulent dyspepsia are common, while constipation or diarrhœa with foul stools and mucus is often found. X-ray examination after partaking of a bismuth meal will show delay in passage of the intestinal content at certain places.

Where the adhesions are in the upper part, *i.e.* around the upper ileum or gall-bladder, dyspepsia is prominent, and is relieved by lying on the back ; while where the lower ileum is affected, or where there is compression of the ascending colon with dilatation of the cæcum or angulation of the hepatic flexure, the signs suggest chronic appendicitis, but the tenderness is diffuse over the right flank and not confined to McBurney's point, rigidity is not present, and there is no fever (Jackson).

These cases are to some degree amenable to medical treatment, including mild aperients such as liquid paraffin, irrigation of the colon, abdominal massage, dieting, attention to the teeth, tonics, &c., and it is only when advanced or rebellious that they come under the surgeon. The measures to be adopted depend on the condition present, and in performing these operations care is needed to attack the condition which is causing trouble. Thus it is little use dividing adhesions or bands which are not producing kinking or where there is marked visceroptosis ; nor is it any use slinging up proptosed organs by suture when the ptosis is due to blocking by veils or bands lower down the course of the intestine. Surgeons naturally tend to favour their special methods, but in these cases, about which as yet little is known, open judgment should be maintained and each case treated on its merits, carefully examining the local condition at operation and attempting to reduce the condition to the normal. Bands should be divided and the raw surface sutured so as to avoid further adhesions and relieve the kink. This applies to the lower ileum and ascending colon (Jackson's membrane) (when the latter is really causing interference with the passage of intestinal

contents through the ascending colon, though this often seems doubtful). Ptosis of viscera may be improved by suturing them up in their normal positions. This applies to the stomach and colon (Rovsing) and the cæcum (Wilms), the former being sutured to the anterior abdominal wall high up, while at the same time the gastrocolic ligament is shortened. The cæcum may be slung up by suturing to the lateral wall of the abdomen. Finally, where such measures fail and the block is largely in the colon the operation of ileosigmoidostomy may be performed ; in this plan the lower end of the ileum is implanted laterally in the sigmoid (Lane). This may prove satisfactory, but should the fæces collect in the colon above the anastomosis excision of the latter will be necessary. This branch of surgery is comparatively new, and the most appropriate methods for each type of affection have still to be accurately learned.

OPERATIONS ON THE INTESTINES

Enterotomy signifies opening the gut for removal of a foreign body or for drainage during operation, the gut being closed by suture before the laparotomy wound is closed.

Enterostomy, or making a fistula into the gut, is described below with colostomy.

Enterectomy, or excision for innocent and malignant strictures, gangrene and growths, has been described in previous sections.

Entero-anastomosis, or union of intestine laterally, end to end, or end to side, has been described in an early section.

COLOSTOMY AND ENTEROSTOMY. In these operations an opening or fistula of temporary or permanent nature is made between the gut and the surface of the body. Of these openings two varieties may be distinguished : (1) the artificial anus, in which all the fæces pass on to the surface, *i.e.* the whole circumference of the lumen of the gut ends on the surface ; while in (2) fæcal fistula only a part of the fæces pursues this course, *i.e.* there is a fistula in the side of the intestine the lumen of which is not occluded. Fæcal fistulæ are seldom made intentionally, since where such openings are made one wants to divert the whole stream of fæces to the surface.

It should be noted that the openings here described are for drainage purposes and are freely open, but other openings are sometimes made, such as jejunostomy for feeding or appendicostomy for lavage, and in these operations measures are taken when forming the opening to prevent the escape of fæces.

Colostomy and enterostomy are done to relieve acute or chronic obstruction, though in the latter instance a lateral anastomosis is better if possible, *i.e.* if the obstruction be not too low down ; hence for chronic obstruction the operation is usually performed for cancer of the rectum. A suitable loop of gut is brought to the surface (the sigmoid is the part most usually employed) and fixed there. The most convenient method is to pass a vulcanite rod through the mesentery to prevent the intestine slipping back, and securing it from further prolapse with a few sutures to the surrounding

muscles and skin, closing the aperture through which the knuckle of intestine protrudes sufficiently to prevent any prolapse of abdominal contents but not sufficiently to interfere with drainage. Where the intestinal obstruction is chronic and there is but little distension the gut is not opened for three or four days and is covered with silk protective to prevent excess of adhesions. After this period has elapsed (or earlier if obstruction becomes worse) the loop of gut is opened along its anti-mesenteric border and fæcal contents allowed to escape. After a few more days, if the colostomy is to
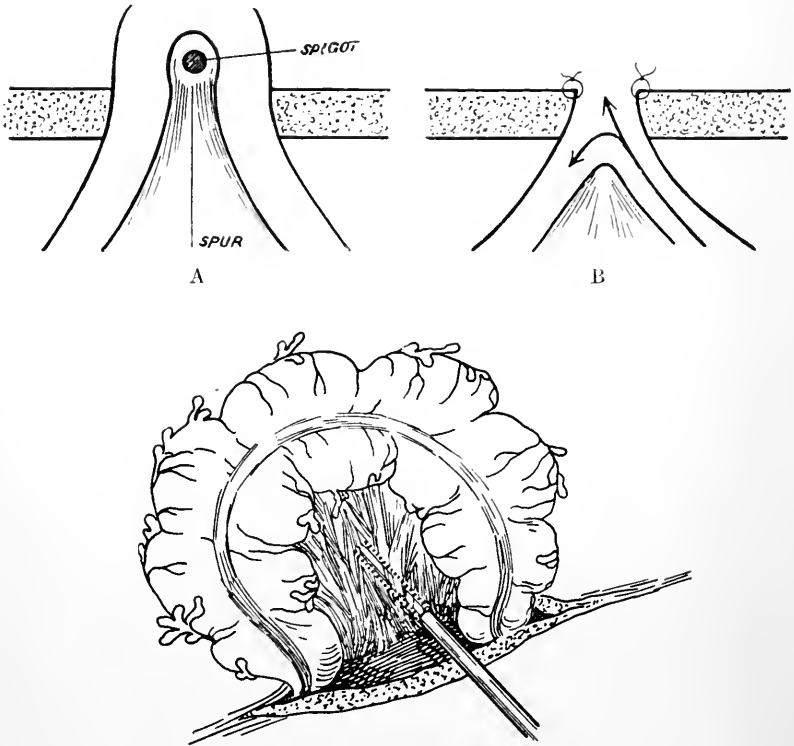
FIG. 80. Sigmoid colostomy : a spigot through the mesentery prevents retraction of the loop inside the abdomen. Sections of : A, Artificial anus (colostomy). B, Fæcal fistula.

be permanent the redundant gut is trimmed away and, later, a colostomy belt fitted, consisting of a spigot passing into the opening to prevent contraction of the latter and a pad encircled with a pneumatic border to prevent escape of fæces. If the colon be irrigated daily inconvenient actions of the bowels will be avoided.

Where obstruction is acute, immediate drainage is needed, and the procedure is as follows : A gut-clamp is placed on the loop selected to prevent extravasation of fæces and a purse-string suture of strong silk inserted ; a slit is cut within the circle of the string and a Paul's tube of glass with rubber continuation inserted so that both flanges are within the gut ; then the purse-string is tightened and tied (Fig. 81).

The purse-string is insufficient to stand the strain of the fæcal contents, which may be under great pressure, so before the clamp is removed a tape is tied round the gut and tube between the flanges, thus securely fixing in the tube. The gut, after removing the intestinal clamp, is fixed to the parietes with vulcanite spigot and sutured as before, and the rubber tube conveys the fæcal effluent to a suitable receptable. The tube sloughs out in four to six days, leaving a colostomy, as after the previous method.

We must now consider the position in which colostomy may be performed. There are several possible positions, as follows : the ascending and descending colon may be drained from either loin ; while from the abdomen the sigmoid may be reached in the left iliac fossa, the transverse colon in the middle line, and the cæcum in the right iliac fossa.

Lumbar colostomy is performed by making a horizontal incision between the last rib and the iliac crest, reaching behind to the erector spinæ and
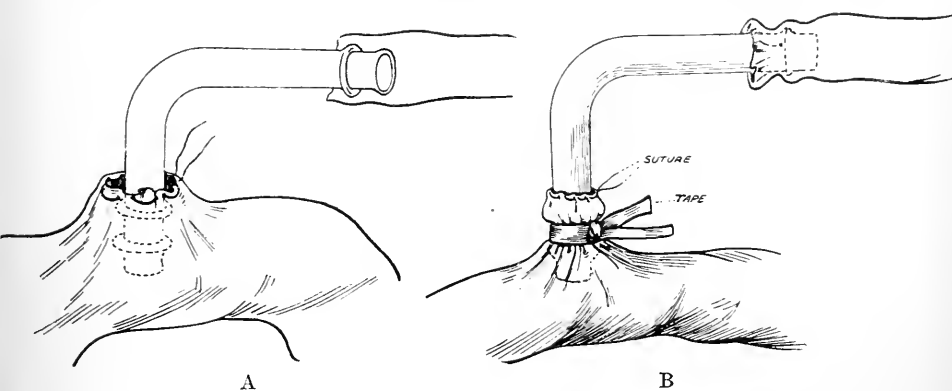
Fig. 81. Draining the intestine with a Paul's tube. A, Tying in the tube with a purse-string suture above both flanges. B, Reinforcing the insertion of the tube with a tape tied between the flanges.

having its centre half an inch behind the mid-point of the iliac crest, *i.e.* at the line of the colon. The incision is about four inches long and divides the latissimus dorsi and external oblique, then the lumbar fascia and origins of the internal oblique and transversalis. The subperitoneal fat and peritoneum are next encountered, the latter opened, and the gut brought to the surface and secured with rod and suture as before. The original plan was to open the colon outside the peritoneum on its posterior surface, and if there be difficulty in bringing the gut to the surface the peritoneum must be closed and this method used.

Inguinal colostomy may be done in the iliac fossa by a muscle-splitting operation similar to that employed for appendicectomy, or by a vertical incision further inwards, opening the rectus sheath and splitting the rectus muscle longitudinally. Either method affords a fair sphincter for the artificial anus. The intestine is fixed as described above.

When operating on the left side (the usual position) the sigmoid is found crossing the pelvic brim and recognized by its appendices epiploicæ, and

tæniæ. It is pulled down as far as possible, for if there be a long piece of free, mobile sigmoid above the artificial anus there is a considerable tendency for prolapse of this part of the gut through the colostomy. In the middle line the transverse colon may be brought out. displacing the rectus outwards, but if the opening is to be permanent it should be brought hrough a split in the muscle, to afford a better sphincter.

The cæcum may be reached on the right side by a similar incision, though this is seldom advisable.

Relative Merits of these Operations. Where a colostomy is to be permanent it should be in front, since in this position it can be more readily reached for attention by the patient himself, and the abdominal muscles split as suggested give a much better degree of sphincter-control.

There has of late been a tendency to revive lumbar colostomy, which had been practically obsolete for many years, in certain cases where the colostomy would only be of temporary nature. Thus for obstruction in the transverse colon right lumbar colostomy has been advocated, so that a second operation for excision of the growth can be performed without the risk of infection from an opening discharging fæces, which is present where inguinal or transverse colostomy has been done.

This risk is, however, trifling with reasonable care, and making a colostomy in the loin adds to the length of the operation for acute obstruction much more than does the making of an anus in the mid-line or inguinal region. Moreover, there may be difficulty in raising the colon from the loin and opening it without fouling the surroundings : consequently we advise for rectal or lower sigmoid obstruction that left inguinal (sigmoid) colostomy be performed ; for obstruction in the descending colon, splenic flexure or upper sigmoid, a transverse (mid-line) colostomy ; while for obstruction in the ascending colon or hepatic flexure it is best to avoid opening the cæcum or ileum, since the liquid fæces of this part of the gut cause great irritation of the skin and infection of the wound. Hence in such cases the lower ileum should be anastomosed with the sigmoid, which will not take longer and be just as safe as a right lumbar colostomy.

AFFECTIONS OF THE ABDOMINAL WALL—HERNIA

Tumours of the Abdominal Wall : Umbilical Polypi : Umbilical Cysts : Umbilical Fistulæ : Abdominal Fistulæ : Causes of Hernia : Varieties of Hernia : Structure of Hernia : Signs of Hernia : Treatment of Hernia : Inguinal Hernia : Congenital Hernia : Varieties : Signs and Diagnosis : Treatment of Inguinal Hernia : Operations for Inguinal Hernia : Femoral Hernia : Signs and Diagnosis : Operative treatment of Femoral Hernia : Hernia about the Umbilicus : Exomphalos : Umbilical Hernia of Infants : Umbilical Hernia of Adults : Hernia through the Linea Alba : Divarication of the Recti : Incisional Hernia : Obturator Hernia : Lumbar Hernia : Gluteal Hernia : Pelvic Hernia : Diaphragmatic Hernia : Irreducible Hernia : Obstructed Hernia : Inflamed Hernia : Strangulated Hernia : Signs and Treatment of Strangulated Hernia : Herniotomy : Treatment of Gangrenous Gut : Operations for Strangulation of Special Herniæ.

SURGERY OF THE ABDOMINAL WALL

THIS group of affections includes many diverse conditions, and it will simplify matters to separate off at once those in which there is a deficiency of the abdominal wall with protrusion of its contents (either actual or potential), which are treated of in the last part of this chapter under Hernia.

The other conditions of the abdominal wall of special importance to the surgeon are tumours and fistulæ, of which the latter are very often situated at the umbilicus.

TUMOURS (SWELLINGS) OF THE ABDOMINAL WALL. The general diagnosis of swellings in this position from those taking origin inside the abdomen is important, and is made by examining the patient in the recumbent position, and while palpating the tumour to ask the patient to raise his head from the couch. The muscles of the abdominal wall are thus rendered tense, and if the tumour be beneath them, *i.e.* inside the abdomen, it becomes less obvious, while if in or superficial to the muscles its outline remains as distinct or becomes more so when the muscles are made tense. Swellings of the abdominal wall may be inflammatory or new growths. Inflammatory swellings are acute and chronic abscesses, gummata, and have the characteristics of these swellings elsewhere.

Of neoplasms occur lipomas, fibro-sarcomas, and rarely epitheliomas. Lipomas occur in the middle line, and are nearly always protrusions of the extraperitoneal fat through congenital or acquired deficiencies in the linea alba, and very often draw out with them a protrusion of peritoneum in the form of a hernial sac (*see* Herniæ).

Fibro-sarcoma. The rectus sheath is one of the places of election for this type of new growth, which occurs as in the form of hard, nodular tumours, growing very slowly for years but ultimately taking on rapid growth and infiltrating properties. These growths are spindle-celled sarcomas of relatively low malignancy, tending to recur locally if not widely excised but not disseminating to distant parts. From their place of origin they are sometimes known as " desmoids." Treatment is thorough removal with a good margin of normal tissue, closing the abdominal wall and strengthening the latter, if need be, with a plastic operation or by inserting a silver filigree.

Phantom tumours are not often met with, and are the result of insufficient observation. Local spasm of the rectus in a fat, flatulent woman
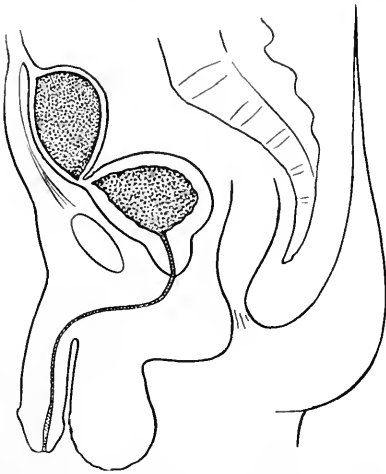
FIG. 82.   Urachal cyst or unobliterated portion of the urachus inside the abdomen.
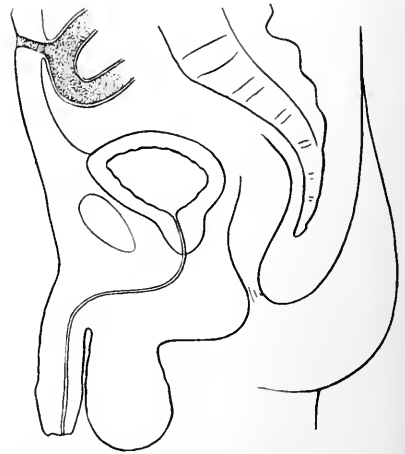
FIG. 82A.   Fistula at the umbilicus due to pervious Vitelline duct (Meckel's diverticulum).

may suggest the presence of a tumour. In such cases it is wise to suggest examination under anæsthesia, when the phantom tumour will disappear or a definite tumour be more distinctly felt. It should be borne in mind that there are tumours which really do vanish, *e.g.* an intermittent hydronephrosis, which may empty through an unkinked ureter.

Tumours in connexion with the Umbilicus. Polypoid growths and cysts are found here.

(1) The polypoid tumour of the umbilicus is found in infants of a few months, resembles a raspberry, and may consist simply of granulation tissue or be made up of epithelial masses derived from the urachus or Vitelline duct, in which case it is to be regarded as an adenoma.

Treatment. The polypoid mass should be excised and the base touched with solid silver nitrate.

Cysts connected with the Umbilicus (urachal or allantoic cysts). These are usually derived from a persistent part of the urachus or allantoic stalk, which is originally hollow and lined with epithelium and forms an extension of the bladder. This stalk should be completely obliterated and turn

into a fibrous cord running from the bladder to the umbilicus. Should the process of obliteration occur at each end of the stalk and not in its middle the secretion of the lining epithelium will continue and a cyst result, lying in and behind the abdominal wall between the pubes and umbilicus. The physical signs of such a cyst resemble those of the distended bladder except that it cannot, of course, be emptied with the catheter. This makes diagnosis simple in men, but in women, in whom the anomaly is less common, the signs closely resemble those of a somewhat adherent ovarian cyst.

In later life these cysts have a tendency to become malignant, infiltrate surroundings, and disseminate widely ; indeed it may be the more rapid growth of incipient malignancy which leads to its discovery, as when small the cyst may escape notice.

Treatment. The cyst should be explored through the rectus sheath and dissected out entire. This may not be an easy matter when it is becoming malignant, as adherence to gut or bladder may render dissection very difficult.

FISTULÆ OF THE ABDOMINAL WALL. By fistula is meant a communication between any of the hollow viscera and the surface. Where the communication is between the peritoneal cavity and the surface it is known as a sinus.

Fistulæ may arise spontaneously or as

FIG. 82B.   Urachal fistula at the umbilicus.

the result of operations and accidents. They may occur between the stomach, intestine, gall-bladder, urinary bladder, kidney, or ureter and the surface. The latter forms are discussed under Surgery of the Urinary System. The umbilicus is a common site for fistulæ, and these may be congenital or acquired.

Congenital Umbilical Fistulæ.   (a) Fæcal fistulæ due to the persistence of the omphalo-mesenteric duct ; or, in other words, a Meckel's diverticulum of the ileum opening on the surface.

(b) Urinary, vesical, or allantoic fistulæ owing to failure of obliteration of the intramural part of the allantoic tube or urachus (the relation of these to allantoic cysts is clear).

The congenital fistulæ are present at birth, or rather after separation of the umbilical cord, and their nature is obvious owing to the discharge of urine or fæces from the umbilicus.

Acquired Fistulæ at the Umbilicus.   Fæcal fistulæ occur at this point, most usually from perforation of tuberculous ulcers associated with tuberculous peritonitis, a fæculent abscess forming which bursts through the umbilicus.

Biliary fistulæ, apart from operation, are also most often found at the umbilicus, and are due to suppuration of the gall-bladder tracking thither along the falciform ligament.

Acquired fistulæ of other parts of the abdomen are nearly always the result of operations, but occasionally of injuries.

Gastric fistula may result as a misfortune after gastrostomy, but is rare if the method of Kader be employed.

Resulting from trauma we may recall the classic example of Alexis St. Martin, where this condition followed a gunshot wound of the stomach.

Biliary fistulæ, except at the umbilicus, are the result of operations on the biliary passages and imply that the common duct is blocked by stone, stenosis, or growth.

Fæcal fistulæ are nearly always the result of operations, seldom occurring otherwise, unless at the umbilicus. These fistulæ result from softened and inflamed gut giving way, either from the severity of the disease or from the pressure of drainage-tubes or tearing during operation, or may be made intentionally with a view of draining the intestine (colostomy), in which case the whole stream of fæces is as a rule diverted, whereas in fæcal fistulæ arising unintentionally there is mostly but partial diversion of the fæces.

Diagnosis. Urinary, biliary, fæcal, and gastric fistulæ are easily distinguished by the presence of urea, bile or hydrochloric acid. Fæces when liquid may not be easy to distinguish from fæculent pus, and sometimes a fæcal fistula is thought to have arisen after opening an appendix abscess, whereas it is merely the separation of some sloughs.

It is important to distinguish the position of the opening of a fistula into the gut, whether of large or small intestine, since a fistula high up the small intestine will destroy life rapidly from inanition, while in the colon such a fistula is simply an inconvenience.

The character of the fæces and the fact that a coloured enema may escape from the fistula serves to distinguish the condition when affecting the large intestine. Where the fistula is high up the small intestine the slightly fæcal character of the discharge, which resembles chyme, and perhaps contains undigested food, reveals the condition and points to the urgent need for restoring the continuity of the intestine as soon as possible.

Treatment. Many fistulæ, especially fæcal and biliary, close spontaneously, and only require dressing for some weeks, employing some soothing ointment, *e.g.* zinc oxide, and lanoline in the former type where the skin is becoming irritated.

Should the viscus into which the fistula opens be near the surface of the abdomen the epithelium of the viscus and that of the skin may become continuous, and the healing cannot take place.

Congenital fistulæ should be tied off at the surface and the fistula dissected back to the viscus from which it arises (gut or bladder), opening the peritoneum where necessary. When the viscus is reached the diverticulum is crushed, tied off, and the intestinal or bladder wall closed over this with a layer of sutures.

Biliary fistulæ following operation usually heal, and may be left for some weeks, especially if the fæces contain bile. Where these fistulæ

persist two months or after a shorter time where no bile reaches the stools the biliary passages should be explored again and a search made for a blocking of the common duct by stone, stricture, pancreatitis, &c., and the condition relieved by removing the block or performing cholecyst-enterostomy as has been described.

Biliary fistulæ arising spontaneously at the umbilicus imply inflammation of the gall-bladder, and demand exploration of the biliary passages, and appropriate treatment.

Fæcal fistulæ require operation :

(1) Where they do not heal or become manifestly smaller after two months.

(2) When due to congenital defect (Meckel's diverticulum).

(3) Where the fistula is high in the small intestine, operation should be done as soon as possible on account of the wasting, weakness, and great irritation of the skin thus caused.

The operation is an exploratory laparotomy. The fistula is plugged with gauze, surrounded with a purse-string suture to prevent escape of fæces, and the abdominal wall thoroughly cleaned with iodine solution.

The abdomen is opened a short distance above or below the fistula to avoid the surrounding adhesions, and the condition examined. Two main types are found.

(1) The fistula leads to a single loop of gut with but few surrounding adhesions (none in congenital fistulæ). In such case the fistula may be excised *in toto* from the abdominal wall and removed with some of the intestinal wall, closing the latter with two layers of sutures in a transverse direction to avoid stenosis. Where much of the gut is involved this part should be removed and the ends joined by anastomosis. This is the method for closing an artificial anus or colostomy.

(2 In cases where there has been much diffuse inflammation around the fistula as in appendicitis or tuberculous peritonitis there may be too many and dense adhesions to allow of the fistula being freed and resected with the portion of gut affected. In such cases the only thing to do is to anastomose the part of the gut above the fistula with that below, thus diverting the fæces, and usually securing the closure of the fistula, the edges of which may be freshened by curetting away epithelium to assist in the process.

Gastric and vesical fistulæ are treated on similar lines.

HERNIA

By hernia is meant the protrusion of some part of the abdominal contents through the parietes, which are defective at the point of protrusion. The term hernia, in conjunction with some other word of definition, is used of various parts of the body ; thus we have hernia of the lung, hernia cerebri, hernia testis, &c., meaning protrusions of these organs from their investments, but when the word hernia is used alone it refers to protrusion of abdominal contents.

There are certain places where the abdominal wall is especially prone to give way, viz. the inguinal and femoral rings, the umbilicus, the linea alba, the obturator foramen, and any place, in the lower abdomen, where the wall has been cut through by accident or surgical interference, unless measures are taken to render efficient the closing of such an aperture, as described in the section on Abdominal Operations.

The causes which tend to the production of hernial protrusions are as follows :

(1) Congenital defects in the wall usually associated with the descent of the testis.

(2) Acquired weakness of the wall dependent on accidents, operation, want of exercise, obesity, &c.

(3) Elongation or sliding of the mesenteries and other peritoneal attachments of viscera, without which the latter do not reach low enough to escape, at any rate into inguinal or femoral herniæ.

The above are predisposing causes ; the exciting cause is :

(4) Increase of intra-abdominal tension, whether constant or intermittent.

(1) Congenital defects account for the larger number of herniæ. The testis and round ligament carry with them in their passage into the scrotum and labium majus respectively a process of peritoneum which should become obliterated in its upper part in the male and entirely in the female. The failure of this process to close is the underlying cause of most inguinal herniæ. It is maintained by some that a similar process accounts for femoral hernia, but this is uncertain. Failure of the intestine to retire inside the abdomen during fœtal life in the affection known as " exomphalos " (congenital umbilical hernia) is another example, as are some instances of diaphragmatic herniæ. In addition to definite apertures there may be deficiencies of the abdominal wall, of congenital origin ; thus in small infants the inguinal ring is sometimes of enormous size, clearly from deficient development of the oblique muscles which form its boundaries, and not from stretching of these as occurs in hernia of long standing in older subjects. There may be deficiency of the interlacing fibres forming the linea alba, resulting in the presence of apertures in this structure through which hernia may take place. The larger femoral canal in women renders the female sex more prone to this form of hernia, while the larger inguinal canal of males renders this affection much more common than femoral in males.

(2) The muscles of the abdominal wall may be weakened from want of use in advancing years, sedentary habits and obesity ; from over-stretching in pregnancy, by other abdominal tumours, ascites, &c. The scar of an operation improperly planned, or which does not heal by first intention, may leave a weak spot ready to give way, or may render the muscles weak by section of one or more motor-nerves of the abdominal tunic.

(3) Looseness of attachment of the viscera, and sliding or elongation of the mesenteries, only applies to herniæ of the lower abdomen (inguinal,

femoral obturator, &c). In order to come through a hernial orifice in these situations such elongation is necessary, for with normal length of mesentery a loop of gut cannot be brought through the inguinal canal.

(4) The intra-abdominal pressure may be raised constantly by pregnancy, tumours, ascites, or intermittently by contraction of the abdominal muscles as in laborious occupation, while the constant cough of bronchitis accounts for many herniæ in old persons. Straining to empty the bladder when there is obstruction to urinary outflow from stricture or enlarged prostate, or to empty the bowel in chronic constipation, to lift heavy weights or in prolonged forcible expiratory efforts, in blowing glass or playing the cornet, also have a similar effect. Obesity and increase of omental fat is a common cause in older persons.

VARIETIES AND FREQUENCY OF HERNIÆ. The following are common varieties : inguinal, femoral, umbilical, ventral, incisional. The other types are rare, viz. obturator, pudendal, lumbar, diaphragmatic and internal. The last variety is discussed under Intestinal Obstruction. Inguinal hernia is much the most common form, more so in men than women, and far more common in male than female children. Femoral herniæ are more common in women than in men, but even in women are much less common than inguinal herniæ. Umbilical herniæ are fairly common in women, less so in men, and are frequent in infants, but are of a different nature to those of adults, as will be described.

STRUCTURE OF A HERNIA. A hernia is usually described as consisting of a ring through which the protrusion emerges, a sac and its contents.

The ring is the aperture in the parietes, the tissues of which are more or less condensed from the pressure of the hernia if of long standing.

The sac is the protrusion of peritoneum, and has coverings derived from the layers of the abdominal tunic through which it passes ; these are neatly enumerated in works on anatomy but become blended together in herniæ of long standing. In certain instances the peritoneal sac is absent over part or the whole of the visceral protrusion (sacless or sliding hernia).

FORMATION OF THE SAC. A certain amount of discussion ranges around the formation of the peritoneal protrusion or sac. In the greater number of inguinal herniæ it is without question the result of a defect in the descent of the testis, and hence of congenital origin. In the case of femoral herniæ it is uncertain whether the protrusion is congenital in some instances and associated with the outgrowth of the femoral vessels, which are supposed to carry a process of peritoneum with them, or whether they are due to increased abdominal pressure, which pushes out a pouch of peritoneum through a weak place in the abdominal wall. Certain observers state that peritoneal pouches are found quite often about the crural ring in children, but if this be so it is curious that femoral herniæ are not more common in young subjects. Indirect inguinal herniæ of old persons, umbilical and ventral herniæ, are certainly of the " acquired " variety, i.e. the sac is pushed through a weak place in the parietes.

The sac consists of the mouth or opening into the abdomen, the neck

or narrow part leading from the mouth to the fundus or body of the sac. The neck may be very short, so that the sac consists of little else but mouth and fundus.

CHANGES IN THE SAC. These are due to inflammation of varying severity. The peritoneum of the sac is exposed to all manner of insults, including the pressure of trusses, while inflammation may originate in the contents of the sac, especially when these consist of intestine. Such inflammation, if acute, may terminate in suppuration and the formation of an abscess in the sac. More commonly the inflammation is subacute, and results in the production of adhesions inside the sac which take the form of bands, constricting the lumen of the latter, perhaps obstructing the intestine or fixing this to the wall of the sac. If occurring at the neck of the sac, when the contents are reduced (*i.e.* inside the abdomen), the neck may be thus occluded and perhaps the hernia cured, or fluid may collect in the sac, especially where there is some omentum adherent in the neck, and " hydrocele of the hernial sac " results. As the result of repeated attacks of subacute inflammation the sac becomes much thickened and its coverings blended into a homogeneous layer, the constituent parts of which are no longer separable by dissection.

CONTENTS OF A HERNIA. Nearly all the contents of the abdomen, except perhaps the pancreas, have been found on occasion in one or other form of hernia. The viscera most usually found are the omentum and small intestine, the former condition being described as *epiplocele*, the latter as *enterocele*.

The vermiform appendix, Fallopian tube, and ovary are not infrequently found in the sac, as are the sigmoid and cæcum ; in the last two conditions there is usually no peritoneal sac over more or less of the hernia.

The bladder may also appear in a hernia, and, being extraperitoneal, will naturally have no sac, and is in danger of being tied off when the sac is ligatured. Where there is such a possibility (where the sac appears very thick) a sound should be passed into the bladder, and it can be directed into such a protrusion of the viscus in a hernia. Should the bladder be injured in this way the wall must be sutured with absorbable catgut and a catheter inserted in the urethra to prevent extravasation.

Loose bodies formed of condensed fibrin are found in hernial sacs of long standing the result of bygone inflammation, and are akin to similar structures found in joints.

SIGNS OF HERNIA IN GENERAL. The patient may be unaware of his condition or may notice a swelling of the abdominal wall; groin, &c., and complain of pain of a dragging, dyspeptic or colicky nature, varying from slight discomfort to the urgent distress of acute intestinal obstruction should the hernia become strangulated. Objectively a hernia presents the signs of a swelling connected with the abdominal cavity, the connexion being further shown by the presence of an expansile impulse on coughing, crying, or straining. The swelling diminishes on assuming the recumbent position, may disappear altogether, or may be reduced, *i.e.* returned to the abdomen

by manipulation on the part of the surgeon. On reduction a characteristic gurgle is perceived or heard where there has been gut in the sac, but if omentum only has been " down " this gurgling does not take place and the swelling has a more doughy or finely lobulated feeling, quite different from the soft elasticity of gut. Further, where the hernia is of any size there will be found resonance on percussion where the content is intestine, but dullness where omentum is present.

It is important to recognize what is meant by an expansile impulse and not to confuse it with the mere shock transmitted by the abdominal wall on coughing, &c. The swelling is taken between the fingers and thumb, and on coughing, if the impulse be truly expansile, the fingers and thumb are forced apart by the expanding hernia, because, owing to the well-known hydrostatic law, the pressure in fluids is transmitted equally in all directions and the increased intra-abdominal pressure from coughing distends the sac in all its diameters and does not merely push the latter forward, as may happen when a solid swelling connected with the abdominal wall is examined.

Other swellings connected with the abdomen or thorax, such as dilated veins or psoas abscess, also give an expansile impulse on coughing ; the diagnosis from these will be discussed under Special Herniæ. The urgent

FIG. 83. Diagram of the internal inguinal ring from behind to show the relation of the deep] epigastric artery, &c.

condition where the expansile pulse is lost from strangulation is discussed under the various complications which may arise in cases of hernia.

Treatment of Hernia. It is owing to the grave risk of the intestine contained in a hernia becoming strangulated and giving rise to intestinal obstruction that the treatment of hernia is of such prime importance. A person with an unreduced hernia may become the subject of intestinal obstruction at any moment. Treatment of hernia is simple in theory : the hernia must be completely reduced into the abdominal cavity and kept there by instruments (trusses) or operation. The most suitable means will be discussed under special forms of hernia.

INGUINAL HERNIA. This form of hernia protrudes into the inguinal canal or through the latter, emerging from the external ring, to pass into the scrotum.

Anatomy. The inguinal canal is the place of egress of the spermatic cord or round ligament from the abdomen, and lies between its inlet, the internal ring, and its outlet, the external ring. The canal is bounded in front by the aponeurosis of the external oblique, behind by the conjoined tendon and transversalis fascia, above by the arching fibres of the internal

oblique and transversalis muscles as they pass to form the conjoined tendon, below by the curved surface of Poupart's and Gimbernat's ligaments. The external ring is a split in the fibres of the external oblique aponeurosis forming a narrow triangle above the outer part of the crest of the pubis just internal to the pubic spine, the sides of the aperture being strong portions of the aponeurosis known as the pillars of the ring. The internal ring is the spot in the transversalis fascia where the cord or round ligament leaves the abdomen, and lies half an inch above the mid-point between the anterior-superior spine and the symphysis pubis ; it is arched over, above, and on its inner side by the internal oblique and transversalis muscles, while Poupart's ligament lies below and to the outer side. The external iliac artery passes below Poupart's ligament, immediately below the internal

FIG. 84. Schematic section of inguinal canal to show relations of a hernial sac with the cord and epigastric artery in : A, Direct hernia ; B, Oblique hernia.

ring, and its branch, the deep epigastric artery, passes upwards and inwards from this point towards the umbilicus and forms an important relation to inguinal herniæ, since the cord lies to the outer side of this vessel and passes inwards in front of it, the transversalis fascia lying in between.

From an anatomical standpoint inguinal herniæ are divided into :

(1) Oblique, indirect or external herniæ, which leave the abdomen external to the deep epigastric artery, following the cord in their whole extent.

(2) Direct or internal herniæ, which burst into the canal to the inner side of the deep epigastric artery, and thus only pass down the lower part of the canal.

(3) Interstitial herniæ, which do not reach the scrotum but pass in between the various layers of the parietes.

From the standpoint of ætiology herniæ in this region may be divided into congenital and acquired, and it may be stated at once that nearly all oblique and interstitial herniæ are congenital, while direct herniæ are always acquired, *i.e.* the sac is formed as the hernia develops, while in the congenital form the sac exists before, sometimes long before, the hernia develops, and is due to errors in development of the vaginal process of peritoneum during the descent of the testis. Herniæ are also divided according to the degree of emergence through the inguinal canal, as :

(*a*) Bubonocele, where the hernia has not reached the scrotum but is in the canal or only just outside it.

(*b*) Complete or scrotal or labial hernia (according to sex), where the hernia has reached the scrotum or labium.

Anatomy of Oblique Inguinal Hernia. As the hernia passes along the vaginal process of peritoneum it will have the relations and coverings of the spermatic cord, viz. :
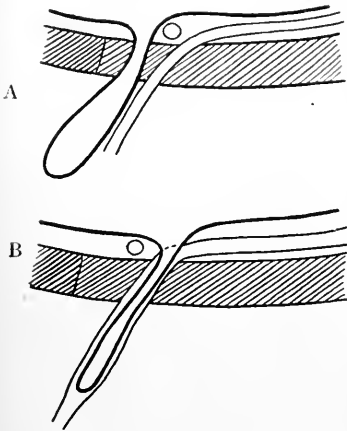
(a) Peritoneum and extraperitoneal fat.

(b) Infundibuliform or internal spermatic fascia, derived from the transversalis fascia.

(c) The cremasteric fascia, derived from the internal oblique and cremaster.

(d) The intercolumnar or external spermatic fascia, derived from the external oblique.

(e) The skin with the dartos or Scarpa's fascia, according to the position of the hernia in the scrotum or groin.

The sac lies entirely inside the cord and has the same coverings, derived from the layers of the abdominal wall, which the testis in its descent forces in front of it.

Anatomy of Direct Inguinal Hernia. In this variety the hernia does not come through the internal ring but enters the inguinal canal to the inner
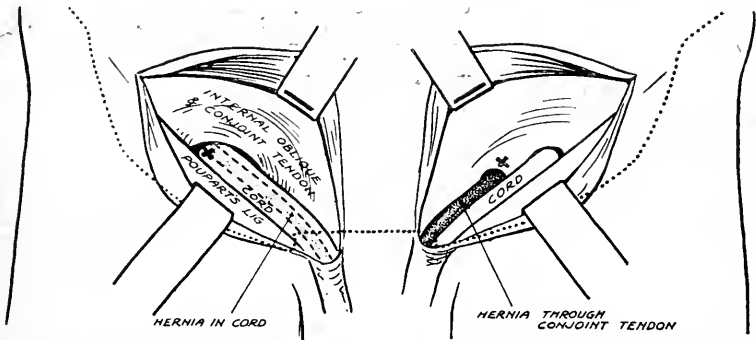
FIG. 85. To illustrate the difference between an indirect hernia on right side and direct on the left in their relations to the spermatic cord; **x** indicates the point of exit of the hernia through the wall.

side of the epigastric artery between this and the outer border of the rectus, in the space known as Hesselbach's triangle. The protrusion may burst through the conjoined tendon or the transversalis fascia, or may push either of these structures in front of it. It follows from this mode of origin that the cremasteric fascia is not one of the coverings, the place of the latter being taken by the conjoined tendon if the latter be pushed out and not broken through ; and as the infundibuliform fascia may not be very obvious, the coverings consist of skin, dartos inter-columnar fascia and the peritoneal sac, reinforced by the extraperitoneal, fatty tissue and perhaps relics of the infundibuliform fascia and conjoined tendon. In these cases at operation the sac is manifestly not in the middle of the cord as in the congenital oblique form, but lies outside the cremasteric fascia of the cord.

CONGENITAL INGUINAL HERNIA. These are associated with and due to errors in the descent of the testis, and include the larger number of inguinal herniæ, all of which are of the oblique variety and of which there are several subdivisions, as follows :

(1) Complete or Vaginal congenital hernia.

(2) Incomplete or Funicular congenital hernia.

(3) Encysted or Infantile congenital hernia.

(4) Congenital hernia associated with undescended testis.

(5) Interstitial hernia.

In the first place, it must be clearly understood that it is the sac which is congenital and not the hernia, which may not be found for months or years after birth. The predisposing cause is present at birth, but unless the mesentery be long enough for the gut or omentum to enter the sac the defect may never lead to the production of a hernia.

ANOMALIES IN THE DESCENT OF THE TESTIS AND DEVELOPMENT OF THE VAGINAL PROCESS OF PERITONEUM.   Normally the process of peritoneum, which descends into the labium or scrotum with the round ligament or testis, becomes in the former instance entirely obliterated and in the latter case converted into a fibrous cord in the portion between the internal ring and the upper end of the testis, the remainder persisting as the tunica vaginalis. Various errors in the closure of this process may take place.

(1) The pouch remains patent throughout its length from the internal ring to the testis. This forms a potential sac for the descent of a vaginal or complete congenital hernia, or from absence of elongation of the mesentery and increase of intra-abdominal pressure, the sac may remain unnoticed for years or till death, or may contain fluid which is reducible into the abdomen—a condition known as congenital hydrocœle (*see* Testis, p. 642).

(2) The pouch becomes obliterated at its lower end near the testis, but the upper part remains patent and communicates with the abdominal cavity. The patency is of variable length, sometimes only extending a short distance along the canal, at others extending a long way down the scrotum. Should gut or other viscus pass into such a sac the condition is known as incomplete or funicular congenital hernia (hernia into a patent funicular process). The vaginal process may be closed at each end but patent in the middle, and if fluid collect in this there results a hydrocœle of the cord (*see* Testis, p. 643).

(3) Where the testis fails to descend completely but remains in the inguinal canal the vaginal process often remains patent, extending into the scrotum below the testis, and is again a potential hernial sac. In other instances the vaginal process will extend in an irregular manner between the layers of the abdominal wall with or without a process passing into the scrotum, the former protrusion forming the sac of an interstitial hernia.

(4) The formation of the vaginal process may be more irregular even with complete descent of the testis. Thus there may be two protrusions of peritoneum through the inguinal canal, one forming the normal tunica vaginalis of the testis, the other remaining patent above and invaginating the tunica vaginalis below. If gut descend into such a sac the resulting affection is an encysted or infantile hernia. These anomalies may occur together. Thus intraparietal herniæ are usual with improper descent of the testis, and we have seen the interstitial sac associated with an encysted hernia on the same side.

Varieties of Congenital Hernia.   (1) *Complete Congenital or Vaginal Hernia.*   In this condition the sac is directly continuous with the tunica vaginalis and the contents of the sac descend right on to and partially surround the testis.   Although the sac is present at birth, the hernia may not develop till puberty or later, and it is distinguished from other types by the fact that the testis is inside the sac and when the contents are down they partially envelop the latter.   (Fig, 86, A.)

(2) *Partial or Funicular Hernia.*   In this condition the sac does not reach so far down the scrotum as the testis, which can be readily felt distinct from the latter.   A large number of herniæ of this appearance are congenital in origin, but acquired herniæ will have the same appearance, and
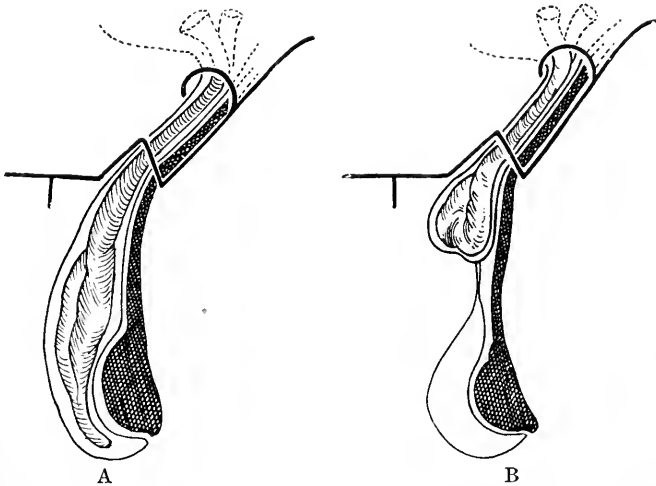
Fig. 86.   A, Congenital vaginal hernia.   B, Congenital funicular hernia.

before operation it is impossible in many instances to say for certain whether the condition is direct or indirect.   Where the hernia develops suddenly, coming right to the bottom of the sac, there must have been a pre-formed sac to receive it; but even where the swelling enlarges gradually this is still possible, for it may be that the sac extends far down the scrotum but, owing to the shortness of the mesentery, the gut only comes down by degrees as the latter becomes lengthened or slips at its attachment.   Funicular herniæ which appear definitely oblique are nearly always of congenital origin (Fig. 86, B).

(3) *Encysted Congenital Hernia,* which is less well described as infantile hernia because the cases first described were found in infants.   In this condition the tunica vaginalis is obliterated above but not in its lower part, which leaves an unusually large tunica vaginalis extending well above the testis.   Into this large tunica vaginalis a second peritoneal protrusion, the hernial sac, is invaginated.   This may push its way into the tunica vaginalis from above, this being surrounded on all sides by the latter, or may project into the latter from the posterior aspect.   Encysted hernia

is only discovered at operation and is puzzling at first sight, especially when the second variety is present, since on opening what appears to be the sac this is found to be shut off from the peritoneal cavity, though leading to the testis, while the cord which projects into the back appears to be of excessive size. This last observation is the key to the mystery, for on opening the apparent cord it is found to contain the second or true hernial sac, and the greater thickness is due to its contents. Where the sac is empty there will be more difficulty, and dissection will be needed before the matter is elucidated (Fig. 86A, A).

(4) *Congenital Hernia associated with Undescended Testis.* Here the descent of the testis is arrested at some part of its course and the vaginal
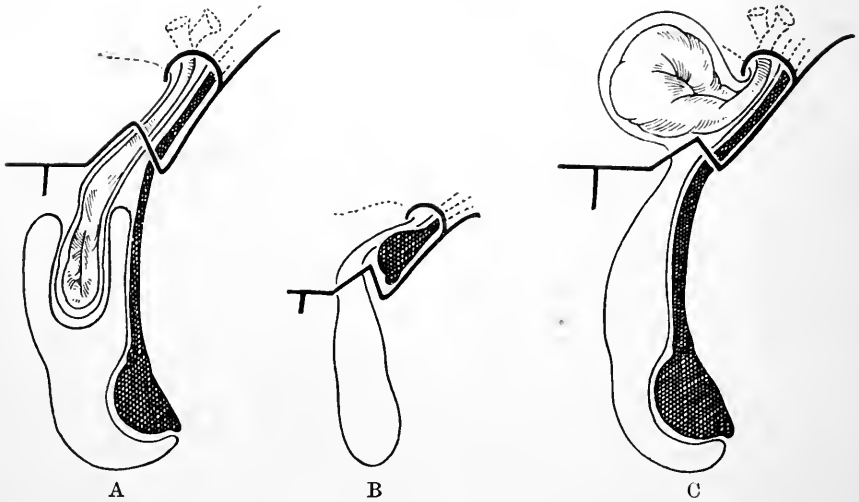
FIG. 86A. A, Encysted (infantile) hernia. B, Hernial sac with undescended testis. C, Congenital hernia with bilocular sac, viz. an intraparietal part above and a scrotal part below.

process remains patent. In most instances the sac extends into the scrotum to a greater or less distance below the testis. In other cases, however, the sac is not in the scrotum but in the thickness of the abdominal wall, or there may be two sacs—one in the scrotum, the other in the abdominal wall—which communicate (Fig. 86A, B) ; these are known as

(5) *Interstitial and Bilocular Herniæ.* Interstitial herniæ are usually associated with improper descent of the testis, but may also occur where the testis is well down. In any case they are due to abnormal protrusions of peritoneum during the formation of the processus vaginalis. Three varieties are described (Fig. 86A, C) :

(*a*) The intraparietal or properitoneal, where the sac is between the peritoneum and the transversalis fascia, *i.e.* inside all the muscular layers of the parietes. Such herniæ extend into the iliac fossa or towards the bladder.

(*b*) The interparietal, where the sac lies between the external and internal oblique muscles.

(c) The extraparietal form, in which the sac passes through the external ring, but instead of passing into the scrotum, which is small and usually ill-developed, is found passing outward and lying along Poupart's ligament, much in the position of a femoral hernia but higher up.

In bilocular hernia there are a scrotal and an interstitial sac as well, both opening into the abdominal cavity through the same neck. The importance of this variety is that the hernia may be reduced from the scrotal into the interstitial sac, and if strangulated, the external signs disappear, though the constriction at the neck is unrelieved.

ACQUIRED HERNIÆ. These occur for the most part in middle-aged and old persons, the most frequent causes being chronic bronchitis and emphysema, constipation, stricture, and prostatic dysuria. But other causes of increased abdominal pressure may account for a good many cases. As regards weakening of the muscular wall, age, obesity, and sedentary occupation have already been mentioned. Another cause worthy of note is appendicitis and operations on this, causing right inguinal hernia.

Right inguinal hernia has been noted in quite a number of instances to develop shortly after operation for appendicitis, especially where an abscess has been present and drained, the reason being doubtless wasting and loss of tone of the lower part of the internal oblique and transversalis, which form an important part of the internal ring. The reason why these muscles waste is from affection of their nerves, either by cutting at operation or involvement in scar-tissue or sloughing of parts of the muscles (hence the greater frequency in suppurative cases). The main point to be learnt is the importance of avoiding injury to nerves whenever possible in opening the abdomen.

RETROPERITONEAL, SLIDING, OR SACLESS HERNIA. This is an important group found in middle-aged and old persons, and is characterized by absence of sac over more or less of the hernia, which generally contain the sigmoid and descending colon or the cæcum and ascending colon. The exact method of formation is not certain. In some instances it is probable that the peritoneum of the iliac fossæ, and with this the portion of large intestine which has no mesentery, slides down into the sac, since it is the large intestine which is typically involved. In other instances the absence of a sac is to be explained by the presence of adhesions resulting from minor degrees of inflammation. Thus in one instance we found the apparent mesentery or broad attachment of the sigmoid continuous with the peritoneum of the front of the abdomen, which could hardly be explained by any manner of slipping. However these herniæ are formed, they are important as offering difficulty at operation, as there is some risk of opening the intestine while searching for the sac, and their treatment demands a slight modification of the usual technique. Apart from operation they cannot be distinguished from other irreducible herniæ.

SIGNS OF INGUINAL HERNIA. There will be found a soft, non-translucent, non-fluctuating, inguinal swelling possibly descending into the scrotum, in which case it will not be confined to the latter but traceable into the

abdomen through the external ring, thus being distinguished from affections of the testis. The swelling has an expansile impulse on coughing, tends to disappear on lying down, returning when the patient stands up. On being returned manually to the abdomen there will be felt a gurgling sensation should gut be present, but a more gritty or gravelly sensation when omentum only is down. After the hernia has been reduced the finger may be passed up the inguinal canal by invaginating the scrotum, and some idea formed of the size of the abdominal rings. Some of the varieties of inguinal hernia may be distinguished by external examination. First the testes should be noted as to position : if undescended on one or both sides, and if the scrotum is ill-developed, the swelling may be an undescended testis either alone or combined with a hernia ; the solidity or softness of the swelling and the effect of coughing on this will make distinction. In some cases of this nature there may be a swelling around the canal in the lower abdomen which increases on coughing or straining, in which case the condition is interstitial hernia. Where the hernia descends to the bottom of the scrotum so as to surround the testis except at the back, the hernia is certainly of the vaginal or complete congenital variety. Where the hernia is in the inguinal canal or only partially down in the scrotum it is not possible to be certain whether it is a funicular congenital or an acquired hernia. In most instances placing a finger in the canal will give some indication of the direction of the hernia and show if it be oblique or direct. But where the hernia appears to come down straight through the abdominal wall, *i.e.* to be direct, it does not follow that the hernia was originally of this variety, since oblique herniæ of long standing displace the conjoined tendon inwards and thus gradually assume the appearance of a direct hernia. In some instances it may be possible, with the finger in the canal, to palpate the epigastric artery to the inner or outer side of the neck of the sac and so determine the variety, but more often this exact diagnosis is uncertain till the canal is opened at operation.

Differential Diagnosis. (1) From femoral hernia the diagnosis is usually obvious, since an inguinal tends to pass down and inwards to the scrotum or labium, while a femoral hernia passes out and upwards. On palpation Poupart's ligament and the pubic spine will be felt below and to the outer side of an inguinal hernia, but above and to the inner side of a femoral hernia. The pubic spine is felt in males by invaginating the scrotum, but in women by abducting the thigh and tracing the tendon of the adductor longus upwards, the spine will be felt just above the origin of this. On reducing a hernia the inguinal variety is felt to pass upwards and outwards but a femoral down and inwards, and when the hernia is reduced the hernial rings are palpated, the pubic spine intervening.

(2) An encysted hydrocœle or hæmatocœle of the cord, *i.e.* a collection of serum or blood in an unobliterated portion of the processus vaginalis, is always tense whether the patient strain or not, and any impulse noted is not expansile, while there are no signs of strangulation (pain, vomiting, shock, constipation). The swelling may be in the canal or reducible into

the latter, but even when reduced the lower end is still felt to be tense and rounded, while a reduced hernia is no longer felt, and in most instances it is possible to manipulate an encysted hydrocœle down and get the fingers definitely above it.   Further, a hydrocœle will be translucent.

(3) *Enlarged Inguinal Glands.*   The swelling is firm or boggy if suppuration be present ; there is no expansile impulse ; the swelling does not emerge from the inguinal canal, which on invaginating the scrotum is found to be normal, but is below Poupart's ligament ; there will often be some infective focus present of leg, buttock, or genitalia to account for the enlargement. Glands of the groin are more often mistaken for femoral than inguinal hernia.

(4) An undescended testis is recognized by the absence of the organ in the scrotum, the firmness of the swelling in the groin, the absence of gurgling on reduction, and the presence of testicular sensation on pressure. Of course, as mentioned, herniæ are often present with this condition.

(5) Tumours of the spermatic cord, such as lipomas or myxomas, are but slightly reducible and have no expansile impulse.   Lipomas may, however, contain a sac, as extrusion of subperitoneal fat may lead the way to protrusion of peritoneum.

(6) Collections of fluid in the inguinal canal :

(*a*) A chronic abscess of the abdominal wall may point at the external ring, and will have an expansile impulse and be reducible to some degree but will fluctuate, and there will be no gurgle on reduction.

(*b*) Collections of fluid passing from the abdominal cavity into a hernial sac, usually of the congenital variety.

Such fluid may be present in ascites, tuberculous peritonitis, or appendix abscess, and the condition congenital hydrocœle falls into this group. The swelling fluctuates, has an expansile impulse, and is reducible but without any gurgle, and in most instances is translucent.

(7) Vaginal hydrocœles are often mistaken for herniæ, especially in children.   The swelling is irreducible, with no expansile impulse.   Usually the fingers can be made to meet above the swelling, showing that it is purely scrotal, and the canal may be felt above to be normal ; but in some instances the upper end of the hydrocœle extends up the canal (*see* Bilocular Hydrocœle).   The fact that such swellings are translucent unless the wall be very thick or blood be effused into the cavity of the swelling (hæmatocœle) usually renders diagnosis easy, though herniæ in small infants may be partially translucent.   However, a tense, irreducible swelling with no signs of strangulation can hardly be a hernia.   A bilocular hydrocœle (en bissac) is tense and has an impulse on coughing, but is translucent, and the part inside the abdomen can be felt and fluctuation obtained between the intra-abdominal and scrotal portions.

(8) Scrotal swellings in their early stages are distinguished by having no connexion along the cord with the abdomen, *i.e.* the cord does not feel thickened.   Later, if the cord be thickened there is some resemblance to an irreducible hernia, but there is no impulse of coughing or gurgle on manipulation or the doughy and finely lobulated feeling of omentum.

(9) A varicocœle is found as an enlargement of the scrotum with an expansile impulse, often reducible to some degree. The swelling is, however, not single but multiple and resembles a " bag of worms," and is thus not often mistaken for hernia. It is necessary to recognize that two or more of the above conditions may be found together, e.g. inguinal or femoral hernia on the same side, while a hydrocœle, varicocœle, and hernia often occur together, and with an undescended testis there is usually a hernia present as well.

Treatment of Inguinal Hernia. The aim is to reduce the hernia and maintain it in this position by truss or operation. In addition to these special measures general means are employed to modify or overcome the causes of the condition, working in the following directions :

(1) To remove or mitigate causes of increased abdominal tension, including the treatment of cough in emphysema and chronic bronchitis, curing strictures of the urethra, removing enlarged prostates, circumcision for phimosis, alleviating constipation, removing abdominal tumours, reducing obesity, &c.

(2) The above measures apply to all forms of hernia, but for inguinal hernia the following may also be of help, viz. :

Improving the musculature of the abdominal wall ; not that cure is by this means possible, but if the muscles are in good order the prospects of performing a sound radical cure are greater and recurrence after operation less likely than when the abdominal wall is flabby and inert. Improvement in the abdominal parietes is attained by exercises directed to strengthening the obliques and rectus abdominis, including various flexions, rotations, and twistings of the trunk, which are fully described in works on Swedish exercises but most shortly and practically in a small work by Lieutenant Müller entitled " My System."

TRUSSES FOR HERNIA. A truss is an instrument consisting of a pad, and some arrangement for maintaining pressure with this over the inguinal canal to prevent the descent of the hernia. The number of devices to attain this end suggest that none are quite satisfactory. The most generally serviceable form is the spring-truss, which consists of a flat steel spring covered with leather, encircling the body between the iliac crest and great trochanter for about three-quarters of its circumference. One end lies over the canal on the affected side and exerts pressure on this, bringing the walls of the canal together by means of the pad consisting of cork covered with leather On the sound side the spring ends behind the anterior-superior spine of the ileum, and is prolonged as a strap which fastens on a stud on the outer surface of the pad. The spring is prevented from slipping up in thin subjects by means of a strap passing under the thigh on the affected side. Where there are herniæ on both sides the spring extends to the canal on each side and ends with two pads. For inguinal hernia the pad, which is oval, has its long axis in the same direction as that of the spring, and its face is directed directly backwards. For a direct hernia the pad is larger and extends over the external ring as well as the canal, and,

especially where the hernia is large and fills the scrotum, the pad is still larger and prolonged as a soft, flexible continuation which is continued into the thigh-strap in this form of truss (scrotal or rat-tailed truss).

The instrument should be worn night and day, and when bathing a rubber-covered truss substituted for the ordinary form. For infants, where the pressure of the pad by means of a spring is likely to cause excoriation of the delicate skin, a rubber belt supplants the spring and the pad is pneumatic.

To measure for a truss, the circumference of the patient is measured from the pubic symphysis round the pelvis, between the iliac crest and great trochanter. To test the fit of a truss, the patient lies down, the
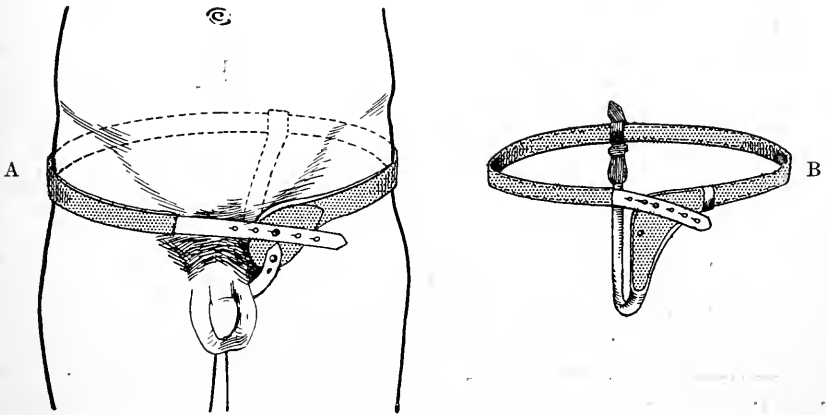
FIG. 87.   A, Truss for inguinal hernia.   B, Truss for inguinal hernia; scrotal or rat-tail type.

hernia is reduced, and the truss adjusted. He then gets up, stands with the knees flexed and thighs abducted, but with the trunk erect, and strains and coughs. If this causes the hernia to come down the pad is not over the canal or the spring is too weak, but if the hernia remains up the truss may be considered to fit. The *skein truss*, made by adjusting a slip-knot of a woollen skein so that the parting of the three portions comes over the canal, is not effective and has little to recommend it.

Results of Trusses. The inguinal canal may close in the first few months if the hernia be kept up. Such cures are not common, for it is difficult to prevent the hernia coming down once or twice during this time, and if it comes down once only the whole benefit up to that moment is destroyed. Many " cures " are more apparent than real, *i.e.* the canal does not close but the body of the infant grows more rapidly than the mesentery and the gut is unable to get into the canal, though the latter be not closed. The sudden recurrence of hernia at puberty when apparently cured in infancy by a truss is in favour of this view.

After a year it is doubtful whether cure is ever effected by trusses, the result being merely palliative.

Cases suitable for trusses are :

(1) Young infants where the surgeon is not used to operating on these subjects, as the operation is often much more difficult than in older children. Where the surgeon has much practice of this sort it matters little how young the operation be done, and we have found cases of but a few weeks old do perfectly well. Still, except amongst the poorer patients, where proper attention to cleanliness is not satisfactory, operation may well be deferred till the patient is a year old, and where the patient can be thoroughly well looked after it is sound policy to put off the operation till two years.

(2) Old persons with poor abdominal muscles, where operation is not likely to be of lasting service.

(3) Persons with other diseases rendering operations dangerous, such as chronic lung, heart, renal or arterial disease, or the subjects of diabetes.

(4) Where the patient is very averse to operation but lives where surgeons and instrument-makers are easy of access. Operation should, however, be strongly urged on such patients before going into the wilder and less frequented parts of the globe.

(5) It is, of course, essential that the hernia be fully reducible.

Against the use of trusses it must be said that, once put on, a truss is needed till the end of life except occasionally in quite young infants ; and the sudden breaking of a truss may endanger the patient's life. A new truss is needed every two years or so, and more often in children. Cleanliness is less easy where a truss is worn. In fine, a truss is a rich man's luxury, but a radical operation is a poor man's necessity.

INDICATIONS FOR OPERATIVE TREATMENT OF HERNIA. (1) All cases where the condition becomes urgent (*see* Strangulated Hernia, &c.).

(2) Irreducible herniæ, with but few exceptions. There are enormous herniæ in old persons where it is doubtful whether the abdomen can contain the hernial contents. Such herniæ are uncommon, though one must admit to an occasional bad five minutes in reducing a very large hernia and wondering whether the last few feet of gut could by any possibility be returned. Other examples are where the presence of other disease renders the prospect of operation as dangerous, or more so than those of an unreduced hernia (which are fairly extensive).

(3) Hernia associated with undescended testis.

(4) All herniæ in persons going to places remote from medical aid.

(5) Most herniæ in persons under forty, especially if they are to lead an active life and are not well enough off to command immediate replacement of a truss should one break.

(6) Where trusses fail to restrain the hernia, which is not common if care be taken by the instrument-maker.

RESULTS OF THE OPERATIVE TREATMENT OF HERNIA. These are, on the whole, very good ; the mortality is quite low—under 1 per cent. Naturally the ultimate results depend on the class of cases treated. In young adolescents suffering from oblique congenital herniæ, where the canal is still small and the abdominal wall good, recurrences are most uncommon,

whereas where the abdominal wall is poor and the hernia acquired and direct or becoming of this type, having been originally oblique, the results are less good and operation may be inadvisable where the hernia can be reduced and controlled by a truss. Nevertheless, where the operation is essential, results in these patients are often surprisingly good if the operation be performed with modern technique as regards asepsis and rational suturing of the abdominal wall, so that the canal is properly strengthened.

RADICAL OPERATIONS FOR INGUINAL HERNIA. These are distinguished from *herniotomy*, or operations where matters have become urgent from the occurrence of strangulation, &c. (*see later*), since in such cases the main object is to relieve the strangulation and return the herniated gut to the
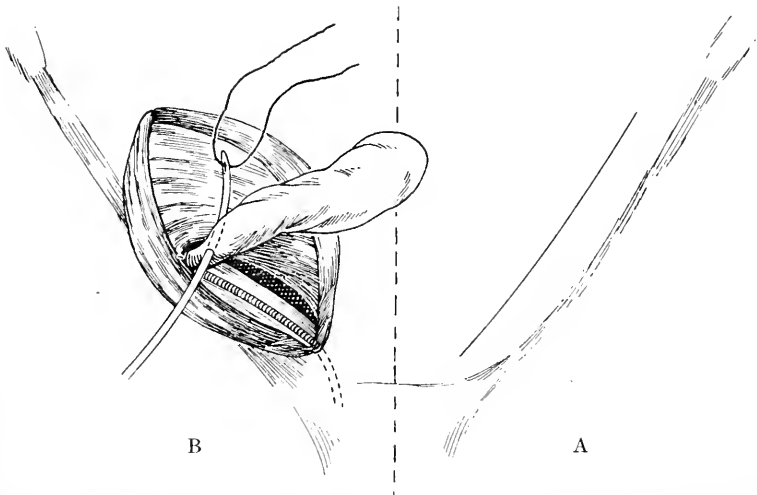
FIG. 88. Radical operation for inguinal hernia. A, Incision splitting the external oblique aponeurosis. B, The sac has been dissected from the spermatic cord and is transfixed preliminary to ligature.

abdomen ; still, in many such cases the wound may be closed by one of the methods of radical operation.

There are two main points in any radical operation :

(1) To remove the sac as thoroughly as possible in the upper portion of the canal, and above all at the internal ring.

(2) Narrowing the canal if abnormally large and restoring it to its normal condition or making it, if possible, more strong than it normally is.

Operation. The skin is shaved and cleaned with solution of iodine and an incision made parallel with, and about half an inch above, Poupart's ligament over the internal abdominal ring, and reaching down nearly to the upper end of the external ring. The superficial epigastric vessels are clamped and divided and Scarpa's fascia cut through (in infants this is often as strong as the external oblique aponeurosis, and may be mistaken for the latter). The external oblique aponeurosis is well exposed and opened parallel with its fibres above the external ring, and the cut edges caught and retracted with artery-forceps. The cord is now dissected out

of its bed, and should the hernia be oblique it is in the cord, but if direct
it will be found coming out to the inner side of the latter.   When lying
in the cord the sac is covered with the cremasteric and infundibuliform
fascia, and can as a rule be seen through these and recognized by its whitish
colour ; but if not, the cord must be split up and search made for the sac,
opening in turn any likely structure, avoiding vessels and the vas, which
is white and of wire-like firmness.   The sac is recognized when opened
by passing up into the abdominal cavity, and detected by inserting a blunt
instrument, e.g. artery-forceps, upwards.   After opening the sac its contents
are reduced into the abdomen, but redundant omentum is ligatured and
excised.   In some instances there are collections of encysted hydrocœles
of the cord (due to imperfect closure of the lower part of the processus
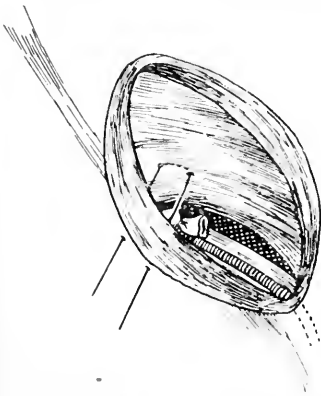
Fig. 88a. Radical operation for
inguinal hernia.   Closing the
internal ring by sewing the
internal oblique to Poupart's
ligament in front of the cord,
with mattress-suture.

vaginalis), which may be opened instead of the
true sac and are shut off from the abdomen,
but if these are traced upwards the true sac will
be found.   Having identified the sac, the next
step is to ascertain if it passes right down to
the testis, i.e. if the hernia be of the complete
congenital variety.

(1) *Treatment of the Sac.*   Where the sac
does not pass down to the testis it may be
bluntly dissected out from the cord, stripping
away tissues with dissecting-forceps, but if of
the vaginal variety it must be freed from the
cord in its upper portion, working round on its
outer and inner sides till it is free from the
spermatic vessels and the vas : the sac is then
divided between clamps and the lower part tied
off to form the new tunica vaginalis.   The
upper part of the sac, or the whole sac in the funicular variety, is dissected
from the vas and vessels up to the internal ring and slightly above this,
where it begins to expand again into the general peritoneal cavity.   The
sac is then pulled down, transfixed as high up as possible and tied, the excess
being cut off half an inch below the ligature to avoid any chance of its
slipping through the latter.   In this manner the sac is obliterated above
its neck and retracts when cut off, so that there is no peritoneal pouch at
this point but a level surface of peritoneum.   Nothing better can be done
as far as the sac is concerned, though other methods are practised, as follows :

(a) The sac may be displaced outwards by passing the ends of the
ligature which secure it along between the peritoneum and transversalis,
bringing them out through the obliques and tying them.

(b) Twisting up the sac and passing it along outwards between the
peritoneum and transversalis and out through a puncture in the oblique,
securing with suture (Kocher).

(c) The methods of Bishop and Macewen, in which the sac is folded up
with sutures to form a sort of pad and secured at the internal ring, are

tedious, and the pad thus formed may act as a wedge and dilate the internal ring, leading to recurrence of the hernia ; they hence are best avoided.

In females the whole sac may always be removed by dissection, since there is no vas or testis to complicate matters.

(2) *Treatment of the Inguinal Canal.* In nearly all infants and most children and young adults nothing further is necessary except closure of the incision through the external oblique aponeurosis and the skin, since the canal is normal except for the presence of the sac, and when this is effectively removed there is no reason why the hernia should recur. Where,
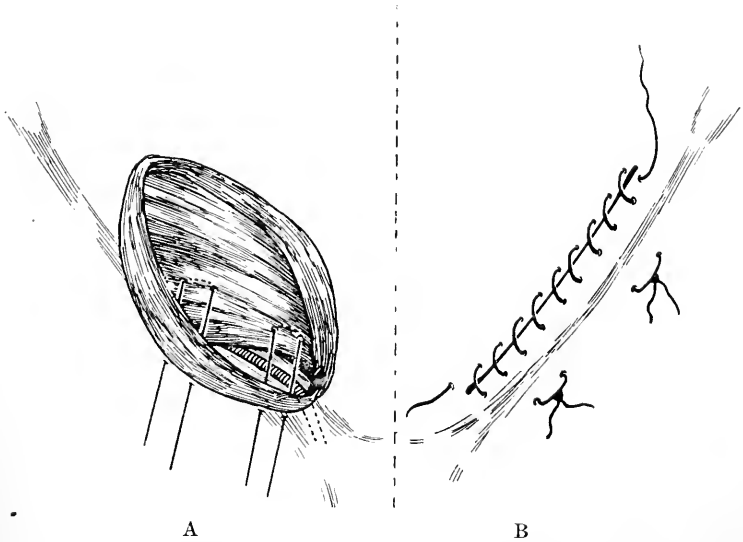
Fig. 88B. A, Radical operation for inguinal hernia. A, Further closing of the internal ring. B, Closing the incision in the external oblique. Note the mattress-sutures tied below Poupart's ligament.

however, the internal ring is large, its dimensions should be reduced to something approaching normal size, and this reduction will be in accordance with the position of greatest weakness.

(*a*) Where the hernia is oblique the weak spot is close to the place where the internal oblique and transversalis take origin from Poupart's ligament. These muscles should therefore be sutured with one or more stitches to Poupart's ligament at this point, *i.e.* in front of and to the outer side of the spermatic cord. (Figs. 88A, 88B).

(*b*) Where the hernia comes directly through the abdominal wall, either being originally of the direct variety or, though at first oblique, having become direct from displacing the conjoined tendon inwards, the weak spot is to the inner side of the cord, and the conjoined tendon should be reinforced or lengthened as regards its insertion by suturing to Poupart's ligament, behind and to the inner side of the cord up to the pubis, thus lengthening the posterior wall of the inguinal canal. This is Bassini's

method of performing the radical operation. In some cases the ring may be closed both outside and inside the cord (Fig. 89).

The best method of introducing these sutures which close the canal is to pass them through Poupart's ligament (*i.e.* the lower part of the external oblique aponeurosis) from the outside, then through the conjoined tendon or internal oblique muscle, and again through Poupart's ligament, tying the knots on the outside of the latter. This affords a better grip for sutures and is less likely to split the ligament than if they be passed through the ligament from the inside of the canal. An exception should be made for the most mesial suture in Bassini's method ; this is best passed through the ligament from inside the canal.

After tying these sutures, which diminish the calibre of the canal (taking care not to constrict the cord too much, or varicocœles and hydrocœles may follow), the external oblique is sutured as before and the skin closed. Closing the external ring alone is of little service, for the hernia commences at the internal ring, and if this gives way the external ring will soon follow suit. Our aim must be to prevent any protrusion occurring through the internal ring. As to suture material, silk or linen-thread may be made perfectly aseptic by boiling, but not infrequently work out after two or three years. Chromicized catgut, which will remain unabsorbed for about two months, is about the ideal material if aseptic, but neither its sterility nor its resistance of absorption is absolutely dependable ; still it is very serviceable.

FIG. 89.   Radical operation for inguinal hernia.   Closing the internal ring by two mattress-sutures, which fix the conjoined tendon to Poupart's ligament behind the spermatic cord (Bassini's method).   Another suture fixes the internal oblique to Poupart's ligament in front of the cord.

The above types of operation are suitable for most cases of hernia, and are practised in slightly modified forms with excellent results by many surgeons. A brief mention is needed of methods suitable for very large or difficult herniæ, for which the above may prove inadequate.

(1) *Halstead's Operations.* (a) In the original method the external oblique aponeurosis was slit up, the sac tied off high up, and the veins of the cord excised, the internal ring closed tight round the vas by sewing both the conjoined tendon and internal oblique to Poupart's ligament ; while the vas was brought out through the external oblique opposite the internal ring, the external oblique being closed behind this so that the vas lay for some distance under the skin. This operation has been for the most part discarded owing to the occurrence of painful varicocœles, hydrocœles, and atrophy of the testis, and is only mentioned to warn the reader lest in operating for a

recurrence of a hernia treated in this manner he cut through the vas in making the skin-incision.

(b) The later plan of this surgeon is similar to the one described above, but in addition to removing the spermatic veins, the cremaster and its fascia are sutured to the under-surface of the conjoined tendon and internal oblique under the cord, and the two latter muscles sutured to Poupart's ligament in front of the cord and the external oblique closed and made to overlap in so doing. The cremaster is poor stuff for closing a hernial ring, but overlapping the portions of the external oblique is sound.

Some surgeons have employed flaps of the rectus sheath or of the muscle itself to assist where the conjoined tendon is very weak.

As, however, there is no posterior sheath to the rectus, it seems bad policy to interfere with the anterior and only layer.

The best method where the conjoined tendon is very atrophic is that of Bloodgood, who displaces the rectus outwards behind the conjoined tendon, suturing the former to the Poupart's ligament and thus widening the insertion of the rectus and making this elastic, resilient structure form the posterior part of the canal, the conjoined tendon being also sutured
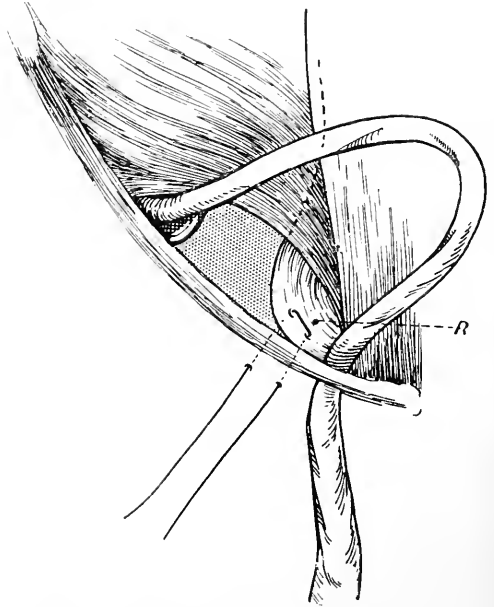
Fig. 90. Radical operation for inguinal hernia. Closing the internal ring by displacing the rectus outwards behind the conjoined tendon and suturing it to Poupart's ligament. (Bloodgood's method.)

to Poupart's ligament over it. The manœuvre is not very difficult : by blunt dissection inwards between the peritoneum and the conjoined tendon the outer edge of the rectus is encountered and pulled out with sutures to the required position. Having employed this plan on several occasions, we can recommend it as useful for large herniæ in old persons with poor abdominal wall.

McGavin employs two filigrees, one between the conjoined tendon and peritoneum behind the cord, the other in front between the tendon and the external oblique, thus making a valve.

Treatment of sacless and sliding hernia or where the gut is very adherent to the sac.

In the operations just described it has been assumed that a complete sac is present, and the contents of the latter are reducible and the sac separable with more or less difficulty from the structures of the cord. In the class now under consideration the sac is absent or only present in part of the

hernia, the gut or other viscera being in direct relation to the other structures of the cord over a considerable extent, whether from sliding of the peritoneum down from the abdomen or from the formation of adhesions is immaterial. In any case the gut cannot be separated from the sac on one aspect of the latter, to a greater or less extent, nor should such separation be attempted, since the blood-supply of the gut passes along in the sac where the gut is adherent, and if the gut be dissected away its blood-supply will be cut away and gangrene is a probable result. In opening such a sac there is danger of opening the gut, and hence it is advisable, where such a condition is possible, to open the peritoneum high up at the internal ring and trace the sac down from the latter. Where any sac is present this should be freely laid open and the adherent part of the gut, together with the over-lying sac, dissected away from the structures of the cord till it is possible to restore the whole to the abdomen : the sac, thus opened up and dissected back, is sutured so that the cut edges come together at the back of the adherent gut and thus form a sort of new mesentery for the latter. The gut, thus provided with a mesentery, is reduced inside the abdomen and the aperture in the sac closed with sutures, since transfixion and ligature are not possible. The operation is concluded by one of the methods described ; these cases are usually in middle-aged or old persons, and the method of displacing the rectus (Bloodgood) is often the most suitable method for closing the canal.

The older operations, where the aponeurosis of the external oblique was not divided and the dissection of the sac was done through the external ring, have nothing to recommend them, being more difficult, tedious, and less certain in their results than those in which the internal ring is freely exposed by opening the external oblique aponeurosis.

After-treatment. The wound is closed without drainage and covered with collodion and gauze, especially in infants, to save fouling of dressings with urine. This plan is also suitable for adults, being more comfortable than a mass of dressings and spica bandage and less likely to produce excessive sweating and possible infection of the skin than the latter method.

Infants naturally remain recumbent indefinitely. Children are kept in bed for ten days, young adults for two weeks, if little more has been done than removal of the sac. In older persons with large herniæ, where a more extensive closure of the canal has been practised, it is well to keep the patient in bed for three weeks. The patient can undertake work or active occupations in six to eight weeks after the smaller operations, but not for two to three months after operations on the larger varieties of hernia.

FEMORAL HERNIA. This form of hernia passes out of the abdomen through the crural or femoral canal to the inner side of the femoral vein and to the outer side of Gimbernat's ligament, reaching the surface at the saphenous opening. There are some rare conditions of hernia in this region sometimes described as femoral hernia, viz. :

(a) The prevascular, in which the protrusion lies in front of the femoral vessels between these and Poupart's ligament.

(b) The extravascular, where the hernia comes through outside the vessels in the muscular compartment containing the ilio-psoas muscle.

(c) The hernia may come through the crural canal but not through the saphenous opening, spreading out instead on the pectineus.

(d) The hernia sometimes comes through a breach in Gimbernat's ligament instead of to its outer side.

Anatomy. The crural canal is bounded above by Poupart's ligament : below by the pectineus muscle covered with its fascia and lying on the pubis, at the upper-border margin of which the pectineal fascia is thicker, firmly adherent to the bone, forming Cooper's ligament : to the inner side is the firm, stiff edge of Gimbernat's ligament or attachment of Poupart's ligament to the ilio-pectineal line ; on the outer side is the femoral vein. The crural canal is the innermost part of the femoral sheath or fascial covering of the femoral vessels and is formed of the same layers of fascia, viz. the junction of the transversalis and iliac fascia ; normally it contains fat and a lymph-gland (Cloquet). The conjoined tendon is an important relation, lying to the inner side of the crural ring ; for a hernia, to reach the canal, passes to the outer side of this structure. Another relation present in some instances is the obturator artery, when it arises abnormally from the deep epigastric (a fairly common anomaly). This vessel may pass to the obturator foramen *via* the inner side of the femoral ring deep to Gimbernat's ligament, and should it lie near the edge of the latter it forms an immediate relation to the crural canal and is in danger of being cut when Gimbernat's ligament is divided to allow of the reduction of a strangulated hernia. Fortunately, the vessel usually either lies at some distance from the edge of the ligament, or may pass to the outer side of the canal, thus usually escaping division. Having passed the canal, a femoral hernia emerges through the saphenous opening and proceeds up and outward along Poupart's ligament, under the skin. The coverings of a femoral hernia are : (1) the peritoneum ; (2) the extraperitoneal fat ; (3) the femoral sheath or fascia transversalis ; (4) the cribriform fascia or thinned part of the fascia lata of the thigh, covering the saphenous opening ; (5) the skin and superficial fascia. In fully formed herniæ these layers are much blended, so that one can only recognize a fascial covering, the subperitoneal fatty tissue, and the peritoneal sac.

Causes. This form of hernia is far commoner in women than in men owing to the different shape of the pelvis in adult life, which causes the canal to be of larger calibre in the latter sex ; it is rare in children. Some observers state that congenital sacs of potential herniæ are also common in children, and attribute this form of hernia also to congenital defect. But the great preponderance of cases in women approaching middle life is against this being the cause in many instances.

Signs. This type of hernia is found as a soft, reducible swelling on the inner and upper aspect of the thigh having an impulse on coughing, and tending as it increases in size to spread up and out beneath Poupart's ligament and being reducible in the contrary direction. The neck is below

Poupart's ligament and to the outer side of the pubic spine but inside the femoral vessels. This hernia is usually found in women over twenty-five years of age.

Differential Diagnosis. (1) Distinction from inguinal hernia has already been discussed.

(2) An enlarged lymphatic gland in the crural canal (Cloquet's gland) occupies the same position as a small femoral hernia, but is irreducible and has no impulse on coughing, besides being tense or solid to feel. The diagnosis of such a gland from an irreducible or even strangulated femoral hernia (especially where the contents of the sac are mostly omentum) is often impossible; hence the rule is to operate in such cases of irreducible swellings in the femoral canal, for to leave a strangulated femoral hernia, till the diagnosis is unequivocal, is to court disaster.

(3) A lipoma in this region can be distinguished by its softness, lobulation, by its edge slipping away on palpation, and by the absence of impulse on coughing. As in the case of a gland, this condition also may not be easy to distinguish from an irreducible, femoral, omental hernia.

(4) A psoas abscess presents itself as a fluctuating swelling coming out under Poupart's ligament with an expansile impulse, but in nearly all instances will be found to be outside the femoral vessels; and there will be found also a swelling above Poupart's ligament, the fluctuation in which is transmitted under the ligament to the swelling in the groin. There is no gurgle on reducing the swelling.

(5) A varix, or distension of the saphenous vein at its upper end in the saphenous opening, is also a soft swelling with expansile impulse. The impulse is, however, often associated with a peculiar thrill unlike the gurgle of a hernia, and if emptied and the finger be kept on the femoral ring the swelling fills up from below with returning blood, while under these conditions a hernia remains in the abdomen and the swelling does not return.

(6) A hydrocœle of the hernial sac (most usual in a femoral sac in consequence of the neck being plugged with omentum, which exudes fluid into the sac, distending the latter) is found as a tense, painless swelling coming from the femoral canal. Translucency will be noted if large enough and there are no signs suggesting strangulation, which distinguishes it from that condition of a femoral hernia.

Treatment. General measures as regards alleviating causes of increased intra-abdominal pressure are similar to those indicated for inguinal hernia. Treatment to improve the strength of the abdominal wall is less serviceable in this condition than the former, since the canal does not pass through muscular walls in the same way.

(1) *Palliative Treatment with Trusses.* The truss for femoral hernia is similar to the spring-truss for inguinal hernia, but the pad is set at an angle with the spring so as to sit lower and be over the femoral ring; also the pad is rotated and in a different plane from that of the spring so as to face upward and backward instead of straight backward, since the direction of the femoral opening is downward and forward while the inguinal canal

opens directly forward. The button to catch the strap from the other end of the spring is on the spring above the pad, so as not to pull the pad up and away from the femoral ring.

(2) *Operative Treatment.* The indications are as for inguinal hernia.

Operation. The sac is exposed by a vertical incision directly over it, freed from its surroundings, and opened. The most characteristic structure found whilst opening the sac is the extraperitoneal fat, which is often redundant and may be mistaken for omentum. After opening the sac, freeing and returning its contents, it is dissected up into the femoral canal. Next, in order to close the sac and the canal at the highest possible point, it is best to proceed by the method of Lotheisen. The vertical skin-incision is prolonged up and out over the external inguinal canal and the latter opened, together with the external ring, as in operating on inguinal hernia. On pulling the cord or round ligament away from the floor of the inguinal canal, the neck of the femoral sac is found lying below the latter, freed and pulled through with the femoral sac, transfixed and tied off as high as possible to avoid leaving any pouch of peritoneum, which might be the origin of another hernia. To block the femoral canal, the conjoined tendon which arches over the inner side of the approach to the former is sutured to Cooper's ligament (a strong band of fascia lying along the ilio-pectineal line just above the origin of the pectineus muscle

FIG. 91.   Truss for femoral hernia.

and continuous with the fascia covering the latter in front and internally with Gimbernat's ligament) (Fig. 92).
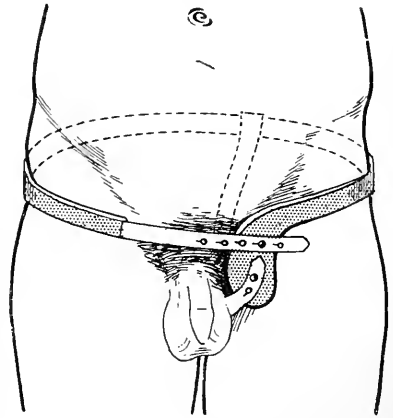
Two or three sutures will suffice for this purpose, taking care not to injure the femoral vein when passing the outermost of these.   In this manner the entrance to the canal is effectively blocked by the resilient conjoined tendon. Additional security may be attained by sewing the pectineus to Poupart's ligament. The external oblique and external ring are closed and the skin sutured. This operation seems the most rational yet devised for femoral hernia, since the canal is blocked at the highest possible point (even before its commencement according to the usual anatomical description), while the conjoined tendon is strong but flexible and not likely to tear away from the position in which it is sutured, as may happen with the more rigid Poupart's ligament. The ideal operative treatment of a hernia aims at preventing the possibility of even the very beginning of a peritoneal protrusion, and this is attained by closing the canal before its commencement.

Other methods of closing the femoral canal may be employed where time is important, as after herniotomy for strangulation.

(1) Having reduced the gut and freed the sac, this is tied off and removed as high up the canal as possible. The canal is closed by suturing Poupart's ligament to the pectineus fascia (Bassini), or to Cooper's ligament (Lockwood). These operations are very similar, but in the second the suture passes further backward, as Cooper's ligament is at the upper and posterior edge of the pectineus and is a much stronger object for holding a suture than the former. The rigidity, however, of Poupart's ligament renders this likely to tear away; nevertheless the results of these methods are very fair (Fig. 93).

(2) The canal (after the sac is removed) may be closed by fixing Poupart's ligament to the pubis either by (a) separating the pectineus from the bone, drilling holes in the latter (one near the femoral vein and one near Gimbernat's ligament) and passing sutures through these and Poupart's ligament (Nicoll); (b) by driving a metal staple through Poupart's ligament into the pubis (Roux). The last two methods may cause pressure on the femoral vein.
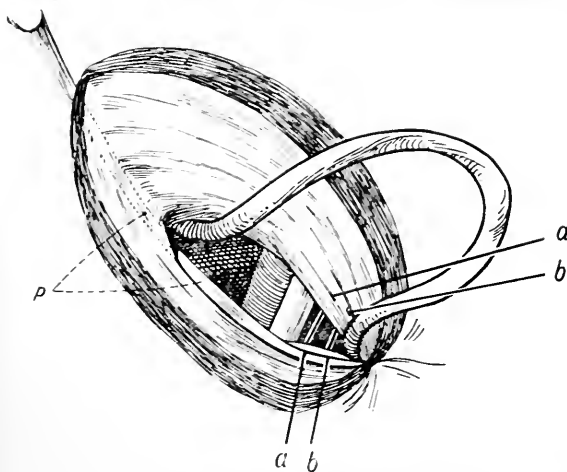
Fig. 92. Radical operation for femoral hernia (Lotheisen's method). The inguinal canal is opened, the spermatic cord lifted from its bed, and after tying off the sac the conjoined tendon is sewn to Cooper's ligament by the sutures *aa, bb*. *p*, Poupart's ligament.

The patient remains two to three weeks in bed, according to the size of the hernia, and no hard work is undertaken for two to three months.

HERNIA ABOUT THE UMBILICUS AND LINEA ALBA. The following varieties are described: (1) exomphalos, (2) umbilical hernia of infants, (3) ventral hernia of adults, (4) divarication of the recti.

(1) *Exomphalos, or Congenital Umbilical Hernia.* This condition is present at birth, and is due to maldevelopment of the abdominal wall in the umbilical region and failure of the intestine, and perhaps other organs, to be retracted inside the abdomen. In other words, the abdominal cavity at the umbilicus leads to a sac within the umbilical cord covered over with a thin, translucent membrane of similar consistence with the cord. Where the protrusion is small it may be tied off by an unobservant midwife, thus strangling a coil of intestine and leading to intestinal obstruction, and possibly later to formation of a fæcal fistula when the ligature separates. There are great variations in these protrusions: in some instances only a small loop of gut is outside the body-cavity, while in others the liver, stomach, and much intestine are in the sac and perhaps adherent to the latter. In the more severe condition death is inevitable, for the contents

cannot be restored to the abdomen, the wall of which is also too deficient to close over the resulting gap when the thin membrane is removed or gives way.

Diagnosis. The more severe types are obvious at a glance from the large bulging, grey, translucent sac at the origin of the umbilical cord. Minor degrees may be suspected where the cord appears very thick at its fœtal attachment, and the presence of impulse when the child cries and the fact that the swelling can be reduced into the abdomen makes the matter certain and points to the necessity of tying off the cord well away from the body at a point where it has assumed its normal proportions.

Treatment. Since the thin-walled sac will shortly give way and fatal peritonitis result, operation is urgently indicated, the sac being cut away and the aperture closed transversely in layers with overlapping if possible, as described under Operation for Umbilical Hernia of Adults. The results are satisfactory in the minor conditions where reduction of the contents is possible.

(2) *Umbilical Hernia of Infants.* This is the only form of acquired hernia passing absolutely through the umbilicus. The umbilicus is formed of scar-tissue, and, as in other places, this, while having a great tendency to shrink, yet if constantly or at frequent intervals stretched will yield and suffer protrusion of the abdominal contents

Fig. 93. Closing the femoral ring by suturing Poupart's ligament to Cooper's.

in this situation. Such stretching at the umbilicus is caused by increased intra-abdominal tension, whether due to cough or straining at stool or micturition. The protrusion occurs only during the first few months of life, while the scar-tissue of the umbilicus is still soft, for once the umbilical tissue has become firmly consolidated it is unlikely to give way, and herniæ in this region are rarely, if ever, through the umbilicus itself in later life.

Diagnosis. There are the usual signs of hernia, viz. a reducible swelling at the umbilicus with impulse on coughing and a gurgle on reduction.

Treatment. This consists (1) in relieving cough, constipation, phimosis, or other causes of increased intra-abdominal tension ; (2) in preventing the descent of the hernia, since if this be managed the fibrous tissue of the umbilicus will contract firmly and there will be little prospect of hernia forming after six months.

The simplest plan is to secure some smooth, flat object, such as a penny, enveloped between layers of strapping over the aperture of the hernia. A belt or rubber with a flat, smooth pad may be worn for the same purpose. It will be noted that the pad is quite flat, as a projecting pad is likely itself to stretch the aperture through the umbilicus and make it still larger. If the hernia be kept back for six months cure will usually result, and if not

complete the method may be continued for a year. In a few instances cure
does not result after this length of time, chiefly from inattention of the
infant's attendants, who allow the hernia to come down occasionally, thus
re-stretching the scar. In such cases operative measures will be indicated,
as described under Ventral Hernia.

(3) *Ventral Hernia.* In this group are included all herniæ through
the linea alba at whatever level, including umbilical hernia of adults, hernia
and extraperitoneal lipomas of the linea alba.

(a) *Umbilical Hernia of Adults.* This condition is rare before middle
life and is more common in women than men, especially in those of an
adipose habit. These patients are often the subjects of emphysema and
bronchitis as well as chronic myocardial and renal affections, and in this
group are found the most stupendous masses of animated flesh that come
under surgical treatment.

The hernial protrusion is usually just above the umbilicus, less often
below. The peritoneal sac is covered with distended and thinned rectus
sheath or linea alba, to which it is usually very adherent. The size varies
from a small nut to a mass the size of the patient's head. The contents are
always largely omentum with a varying amount of small or large intestine.
Inflammation owing to pressure and partial strangulation are frequently
occurring, so that the contents are often adherent to the sac and each other,
and consequently irreducible to a greater or less degree.

Diagnosis. A partially reducible swelling under the umbilical cicatrix in
a middle-aged woman with impulse on coughing, and consisting partly of
doughy omentum, partly of gurgling gut, can hardly be mistaken for
anything else. Where the mass consists entirely of omentum and is quite
irreducible it may resemble a lipoma of the abdominal wall, but in the
latter case the edge will slip under the finger in quite a different manner
from the feeling where a hernia is present. Herniæ in this situation some-
times acquire enormous proportions, rivalling in capacity the rest of the
abdominal cavity.

Treatment. Where the hernia is completely reducible it may be restrained
by an abdominal belt, which should fit flat over the rupture and not have
a pad. This, however, often fails to have the desired effect, and many of
these herniæ are in part irreducible when first encountered, and are there-
fore inapplicable for belts. The results of a well-planned operation are so
good that this is advisable in most examples unless grave organic disease
of heart or lung renders anæsthesia dangerous, though in such cases intra-
spinal anæsthesia can usually be employed with success. Operative measures
are all the more imperative when signs of inflammation, obstruction, or
strangulation arise, and as these signs often come on somewhat insidiously
and not in the sudden manner found in inguinal or femoral hernia there is
a tendency to procrastinate and use palliative measures such as ice-bags
or enemata. This line of action, or rather inaction, is to be strongly depre-
cated, and we strongly urge that cases of umbilical hernia presenting any
departure from the normal in the way of tenderness, tenseness, or irreduci-

bility should be operated on at once lest the condition becomes worse. Early operation will usually be successful.

In order to understand the procedure adopted it is necessary to consider the effects of the action of the abdominal muscles, especially as regards their pull on the linea alba. The obliques and transversalis, when contracting, tend to pull the linea alba apart, as the resultant of their forces is horizontally outwards. Hence a vertical opening in the linea alba will be pulled open by these muscles, but the edges of a horizontal opening will be drawn closer together by the same muscles (Fig. 94). Consequently, in closing an aperture in the linea alba our aim should be to convert this into a horizontal slit and at the same time to overlap the layers of the rectus sheath. The operation advised is of the type advocated by Mayo.

Operation. An elliptical incision with its long axis horizontal is made embracing the hernia and extending some inches on either side of the latter, so that its extremities are at least as far out as the outer borders of the rectus on either side. This incision extends down to the rectus sheath through the fat, which is dissected from the rectus sheath till the neck of the sac is encountered. In this manner a large mass of fat is eventually removed with the sac and skin over it (lipectomy), which saves much time and improves the result. The sac is opened close to its emergence from the linea alba or

Fig. 94. To illustrate the combined action of the oblique muscles of the abdomen, and their effect on the operation for an umbilical hernia.

rectus sheath, since there is less chance of meeting adhesions here. When the sac is definitely opened it is slit up and the contents examined. Usually the intestine may be returned without much difficulty, for the adherent part is mostly omentum. No time is wasted in freeing the latter from the sac ; it is simply freed close to the neck till it is found emerging freely from the abdominal cavity as a strand of varying thickness. The omentum is then pulled down, ligatured in sections (if in large amount), and cut off beyond the ligatures. The stump falls back inside the abdomen while the adherent part with the sac is cut away in one mass, close to the abdominal wall. If the intestine be adherent it must be carefully dissected off the sac, or possibly the part of the sac which is adherent returned with it to the abdomen, having dissected the latter from the subcutaneous tissues. Having thus disposed of the contents of the sac, it remains to close the ring or hernial aperture. The aperture of the ring is enlarged laterally till the rectus is encountered ; this gives the line of cleavage between the layers of the rectus sheath, the anterior layer of which is separated from the posterior for a considerable distance around the hernial orifice. This is

easy except in the middle line, where the blending of the layers to form the linea alba offers some difficulty. Having well separated the layers, the posterior is sewn up in a horizontal direction with continuous suture. Next the anterior layer is overlapped in a horizontal direction with mattress sutures, which pull the lower edge under the upper (three to five mattress sutures will suffice), and the loose edge is then tacked down with interrupted sutures to the sheath lying under it; the skin is closed horizontally. In this manner the hernial ring is closed horizontally with a good overlapping of the edges. If additional strength be required (which we do not find necessary at this part of the abdomen), a filigree of silver wire may be placed between the anterior and posterior layers of the rectus sheath (Fig. 96).

(b) *Hernia of the Linea Alba and Extraperitoneal Lipomas.* In this condition there is a deficiency of the linea alba, either congenital or acquired, from strain and involution of the tissues, since it is found most often in middle-aged men, between the umbilicus and ensiform cartilage. These herniæ are usually of small size, and present the characters of a partially reducible swelling with some impulse on coughing and of doughy feel, suggesting fat. Pain and dyspeptic symptoms may be present. As mentioned, reduction is often incomplete, as in most instances there is a small peritoneal sac surrounded by a mass of extruded extraperitoneal fat, the latter being irreducible. Less often there is no sac at all, the protrusion consisting entirely of extraperitoneal fat.

FIG. 95. Diagrammatic section through an umbilical hernia, showing that the contents (omentum and bowel) are adherent over a large part of the sac, but that close to the neck the peritoneal lining is free and the cavity of the sac can be readily entered in this region.

Diagnosis. The larger forms resemble small umbilical herniæ; in the smaller varieties it is impossible to say before operation whether there is a sac present.

Treatment. As complete reduction is seldom possible, operation is usually indicated, and this should be on the lines laid down for umbilical hernia, viz. removing the sac and suturing the ring transversely with overlapping.

(4) *Divarication of the Recti.* This condition is not properly a hernia at all, since there is no sac but simply a great stretching of the linea alba so that it becomes many inches wide and correspondingly slack and weak. The abdominal contents bulge forward between the recti muscles, and the condition is only found in women after repeated pregnancies.

Treatment. An abdominal belt will generally meet all requirements, but in severe cases more comfort is obtained by an operation, splitting the linea alba in its length and overlapping the edges widely, fixing the lower leaf with mattress sutures.

INCISIONAL OR POST-OPERATIVE HERNIA. This condition results from the giving way of a scar following laparotomy, and will usually be avoided

by opening and closing the abdomen in a valvular manner or splitting the muscles as has been already described. These herniæ may also follow accidental wounds and are uncommon after wounds which heal by first intention, but may result even after well-planned operative wounds where suppuration or sloughing has taken place. They are also far more common
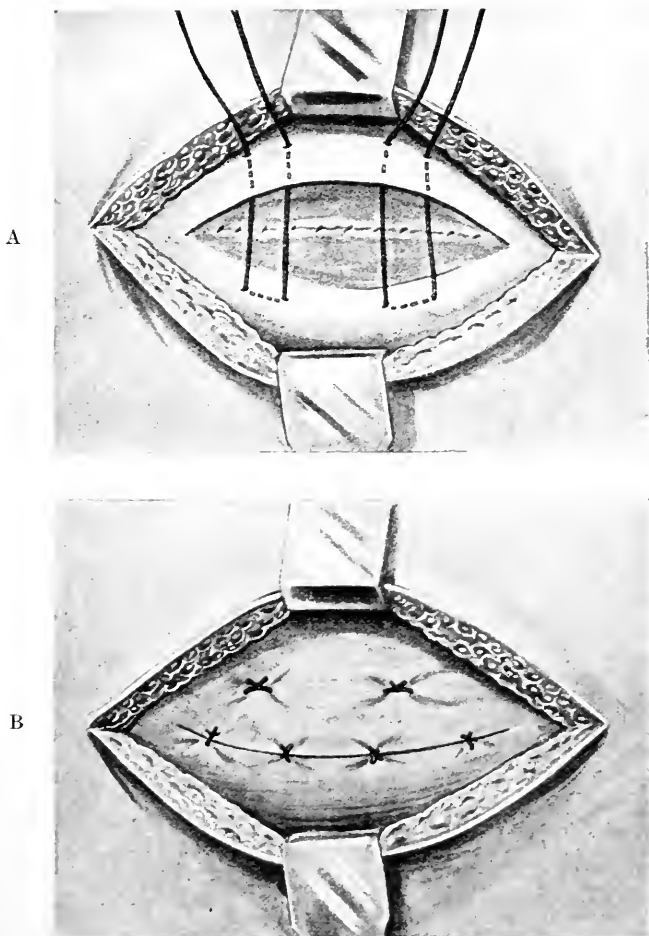
Fig. 96. Mayo's operation for umbilical hernia. A, The peritoneal layer is closed and mattress-sutures have been inserted to produce horizontal overlapping of the rectus sheath. B, The mattress sutures are tied (seen above) and the overlap is secured with interrupted sutures.

after operations on the lower than the upper abdomen. Suppuration in a wound where the muscles have been cut across their length, as in the old-fashioned methods of opening appendix-abscesses, was a fertile source of incisional hernia. Indeed appendicitis and its sequelæ account for the larger number of cases.

Diagnosis. This is simple, for an abdominal scar will be found which may be prominent on standing and which bulges on coughing or straining,

and when the patient is recumbent a hole through the parietes can be felt under this.

Treatment. The smaller varieties may be cured in their commencement by the use of a well-fitting abdominal belt, but this is seldom of any use after three months, after which time operation is indicated, for palliation is the most that can be hoped for if a belt be used.

The operation varies with the site of the hernia.

The sac should be exposed and opened with care, remembering that the intestine is often adherent to the scar. If this accident occurs the gut is sutured and the sac opened elsewhere at a little distance from the scar. The omentum and gut are then freed from the scar, if possible, though it may sometimes be necessary to return gut and sac together. The peritoneum is then closed, and with the fascia transversalis dissected off the muscles around the orifice of the hernia till a good exposure of the relations of the latter is made. The latter must now be closed according to its position. In the linea alba, when small, it may be closed horizontally as described for umbilical hernia. A large vertical opening in the linea alba can hardly be closed in this way and must be sutured vertically, overlapping the layers as much as possible with mattress sutures. In the appendix region an attempt is made to restore the crossing of the muscles in the normal manner, dissecting wide of the ring to find the muscles, as these are often much bound up with fibrous tissue or have become fibrous. In such cases careful overlapping or interdigitating of the layers of muscles should be practised, and will often give excellent results. Finally, where the surgeon is dissatisfied with the strength of the material to hand for closing the gap, he may increase the strength of the abdominal wall by the inclusion of a wire-netting or filigree of suitable size. This should be placed outside the peritoneum, and the muscles closed over it as well as possible. Where, owing to the size of the sac and adherence of its contents, the peritoneum cannot be made to cover over the gap, the filigree may be laid on the omentum or even on the gut. Such measures seem dangerous, but good results are reported (McGavin). The more practice a surgeon has at this sort of operation the less need there is for these artificial supports.

OBTURATOR HERNIA. In this rare form of hernia the protrusion of abdominal contents passes through the canal for the obturator vessels and nerve at the upper inner angle of the obturator foramen.

The condition is most usual in middle-aged women who have become recently thin, and possibly loss of fat in the obturator canal may be a determining factor. This form of hernia has practically never been recognized clinically except when strangulated, and then has usually been discovered when operating for intestinal obstruction, of which it then, of course, forms a variety. Occasionally, in addition to the signs of intestinal obstruction there will be noted some fullness below the femoral ring and pain down the thigh to the knee (from pressure on the obturator nerve) and tenderness or swelling of the obturator region on rectal examination, all of which are elusive signs. The sac, in being forced through the obturator canal, may

carry in front of it some of the obturator externus, and lies under the pectineus ; hence is never large, and if strangulated the portion of gut involved may be only part of the circumference of the lumen (*i.e.* a Richter's hernia).

Treatment. The hernia is met with at a laparotomy for obstruction, and even if suspected is best approached in this way. The loop of gut is disentangled from the ring, enlarging the latter upwards if necessary (the vessels and nerve are below the sac). If the patient's condition be good a radical cure may be attempted, but if grave the abdomen is closed and this done at a second operation ten days later.

The sac is exposed in the upper part of Scarpa's triangle after splitting the pectineus muscle and dissected up to the obturator canal, and then pushed inside the abdomen. The abdomen is opened and the sac pulled through the ring, and thus invaginated and sutured firmly to the parietes (Corner), after which the wounds are closed.

LUMBAR HERNIA. This comes to the surface in the triangle of Petit between the external oblique, the latissimus dorsi, and the crest of the ileum. It usually follows as the result of opening a large abscess in this region (*e.g.* a perinephric abscess), but is a very unusual complication. It presents the usual signs of hernia and is treated as other incisional herniæ.

SCIATIC AND GLUTEAL HERNIA. These are very rare, and protrude through the great sciatic notch below or above the pyriformis respectively. If large a bulging tumour is present in the buttock, which may be resonant and with an impulse on coughing. When smaller they are only recognized, if strangulated, as a variety of internal hernia when operating for intestinal obstruction.

Treatment in any case is best by laparotomy, on account of the danger of wounding the gluteal artery if approached from the buttock : the ring should be closed from inside the abdomen.

HERNIA THROUGH THE PELVIC FLOOR. These are almost always found in women and associated with prolapse of the uterus and sinking of the pelvic floor from injuries in parturition, are known as cystocœles, rectocœles ; and are described in works on gynæcology. Pudendal, vaginal, and rectal herniæ have been described but are too rare to require more than mention.

DIAPHRAGMATIC HERNIA. This condition may result from congenital defects of the diaphragm or from injuries, either crushes, which burst the diaphragm, or punctured wounds, in which case the hernia may be strangulated and urgent signs be present from the commencement.

Where the hernia is not strangulated the physical signs may suggest a pneumothorax if the chest be examined, *i.e.* there will be hyper-resonance, diminished breath-sounds, and metallic tinklings heard on auscultation, while the note may be altered on drinking if the stomach be in the hernia. The breath-sounds and vocal resonance are much less diminished than in pneumothorax. X-rays may afford valuable help, showing an elevation of the diaphragm which is irregular in hernia but dome-shaped in paralysis of one side of the diaphragm, and may give rise to somewhat similar signs. Displacement of the heart may also be considerable. In urgent cases where

strangulation has occurred the signs will suggest intestinal obstruction but there may be hæmatemesis if the stomach be in the hernia, while some of the above signs in the thorax will give a clue.

Treatment. Laparotomy, reducing the condition, if possible, and closing the aperture in the diaphragm—all of which may be very difficult.

SECONDARY CONDITIONS OF HERNIA. At present we have been discussing herniæ which are reducible and in which no secondary changes have taken place. There remain now to be considered such affections as may result in the course of a hernia. The following conditions of a hernia are described : (1) reducible (as already described), (2) irreducible, (3) obstructed or incarcerated, (4) inflamed, (5) strangulated.

(2) *Irreducible Hernia.* A hernia may become irreducible from various causes :

(*a*) The most common is the presence of adhesions, which either fix the contents to the sac or glue the contents together so that they form a mass whose bulk will not allow of its passing through the narrow neck.

(*b*) Contraction following inflammation may narrow the neck or some part of the fundus of the sac so that the contents will not pass beyond the narrowed part.

(*c*) There may be so large a deposit of fat in the omentum or mesentery as to prevent their return through the neck.

(*d*) The mere size of some herniæ may prevent their reduction because there is not room inside the abdominal cavity to contain the contents.

(*e*) Where the hernia has no sac or one in part only of its extent (sliding hernia) it will also be irreducible, since the sac will need to be invaginated through the neck to accomplish reduction.

Signs. In most cases the condition is sufficiently obvious : the hernia has often not been reduced for years, and no effort on the part of patient or surgeon can bring this about. Where irreducibility is of recent date it may be a question of skill on the part of the manipulator. Mere irreducibility causes no further signs than the presence of a hernia does. Where colicky pain, dyspepsia, &c., are noted we may be sure that obstruction is already commencing.

Treatment. Where the irreducibility is of recent origin, should manipulation fail, the patient is placed in bed with the foot of the latter well elevated, which will fairly often effect reduction. In cases of any standing and where such measures fail, operation is indicated in nearly all cases, since an irreducible hernia may become strangulated at any moment. The operation is of the same nature as already described for the cure of reducible herniæ, but in nearly all cases adhesions inside the sac will have to be dealt with. Where the patient's condition is so poor as not to warrant an operation, the hernia being very large, it may be supported by a *bag-truss*, which simply takes the weight of the hernia from the sac but in no way precludes the possibility of strangulation.

(3) *Obstructed Hernia.* This is sometimes called *incarcerated*, which is a term meaning little. In this condition there is partial obstruction to

the lumen of the intestine without interference to the blood-supply, and as it usually occurs in large intestine, may be regarded as chronic or subacute intestinal obstruction—the passage of fæces, and later of flatus, being prevented.

The hernia will be irreducible and more than usually tense, while the patient complains of colic, nausea, and later of vomiting ; an impulse may be present in the hernia ; gradually, if not relieved, the condition passes into one of acute intestinal obstruction or strangulation of the hernia.

Diagnosis. This condition may be regarded as an early stage of strangulation which is coming on slowly. Such a hernia is not tender at first but irreducible, and an impulse on coughing is often present though less marked than usual, while the tension of the sac becomes increased and doughy masses of fæces may be felt through the wall of the sac.

Treatment. A patient with such a hernia should be placed in bed with the feet up and attempts made to reduce the hernia by manipulation, enemata being given to assist in the passage of fæces and flatus. If these measures fail after two or three hours (success being evidenced by reduction of the hernia or at least diminution of the swelling and cessation of colic and vomiting) operation should be performed, as in many cases this course is essential, and the longer it is delayed the less become the chances of the patient. When in doubt in such a case the best plan is to operate.

(4) *Inflamed Hernia.* A certain amount of inflammation or mild peritonitis arises in nearly all herniæ of any standing from pressure of trusses, belts, stagnation of fæces, partial strangulation, etc., as shown by the presence of adhesions in and about the neck of the sac. The milder degrees of inflammation may take place without any symptoms worth mention, but should inflammation be more acute the hernia will present signs suggesting strangulation, the swelling becoming tender, tense and hot, possibly red on the surface, and is always irreducible, though an impulse on coughing is present. Fever is present, which is unusual in strangulation, while obstructive symptoms, vomiting, and constipation are less marked than in true strangulation. Inflammation occurs most often in femoral epiplocœles and umbilical hernia of adults.

Treatment. Since the diagnosis from strangulation is difficult, it is best to operate at once on these cases, for gut may be strangulated by adhesions inside a sac, while the neck is free and an impulse on coughing is present ; this is especially the case with umbilical herniæ. We are in the habit of operating early on all umbilical herniæ where the signs point to obstruction, inflammation or strangulation, and the results are most satisfactory, since it has been clear in many instances that early operation has saved the patient from the imminent danger of strangulation which was present under the guise of inflammation. Similarly, an inflamed femoral epiplocœle cannot be distinguished with certainty from a partial enterocœle (Richter's hernia). Therefore any tender lump in the femoral canal should be explored, for should it prove to be an epiplocœle or inflamed gland no

harm is done, while where the condition is strangulated partial enterocœle the patient's life is probably saved.

(5) *Strangulated Hernia.* In this condition the hernial contents are snared in the sac, so that the blood-supply of the involved viscera is obstructed, and if the viscus should be intestine its lumen is naturally obstructed as well. Strangulation without block of the intestinal lumen may take place where omentum alone is strangulated or where only part of the circumference of the gut is in the sac (Richter's hernia) or where a diverticulum, such as the appendix or Meckel's diverticulum, is thus snared (Littré's hernia). As the result of interference with the blood-supply the gut will eventually become gangrenous and give rise to peritonitis or a fæcal fistula should the patient survive. The condition of the snared gut is exactly the same as that where a loop of intestine is caught under a band, except that the portion snared is outside the abdominal cavity in the hernial sac (*see* Obstruction by Bands and through Apertures, p. 236). The following causes of strangulation are described :

(*a*) The forcing down of a hernia into a congenital sac by sudden effort, the neck being too small to accommodate the intruding viscus without strangulation. This is the usual cause in children and young adults.

(*b*) Strangulation in a hernia, which is already down and perhaps irreducible, by the protrusion of more gut or omentum, which increases the tightness at the neck.

(*c*) Obstruction or inflammation of the part already down, causing increase in its bulk and thus adding to the tightness at the neck.

The site of strangulation is usually at the neck, either from the condensed tissue of the sac itself at this point of irritation or by the dense structures surrounding the latter, *e.g.* Gimbernat's and Poupart's ligaments in femoral hernia or the linea alba in umbilical hernia. Less often the snaring is due to some narrow strait in the body of the sac, such as is caused by bands of adhesions or a hole in the mesentery or omentum.

Pathological Anatomy. This resembles that of acute obstruction by bands, &c. The strangled gut becomes purple and finally black, from venous obstruction. There is exudation into the substance of the gut so that it becomes thickened and œdematous, while fluid is extravasated from its peritoneal surface, filling the sac with fluid, which may be clear, or hæmorrhagic in cases where the strangulation is severe, and especially if prolonged " taxis " to reduce the hernia has been employed. The loop of gut is distended with gas. If the obstruction be removed at this stage the gut will soon return to its normal colour and contractile power. Should the strangulation persist, the peritoneum loses its gloss from desquamation of its endothelium and the odour begins to be musty, but if at this stage peristalsis and the colour return (after freeing and relieving the constriction) it will recover. Still later the gut becomes flaccid and remains so after the obstruction is removed ; the colour alters to grey or green, while the odour is notably putrid, and it is clear that recovery of the strangulated part is impossible and resection essential. The parts most affected are at either extremity

of the loop where the pressure of the neck is felt, and here gangrene occurs earlier than elsewhere, so that these points must be carefully examined before returning the loop of intestine. The gut above the point of strangulation becomes distended (though more slowly than the loop actually strangled) and filled with liquid fæces, is congested, and will finally develop peritonitis. These changes develop above the site of strangulation even where the lumen of the gut is not completely blocked.

When omentum alone is strangled it will become inflamed and adherent to the wall of the sac, and then, obtaining nutrition through the vessels of the latter, may escape from becoming gangrenous. In some instances gangrene of the omentum arises, but it seldom becomes putrid with the
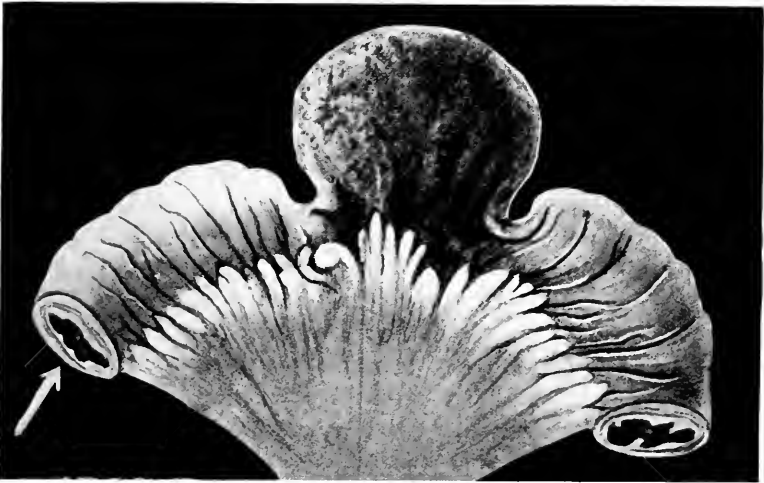
Fig. 97. Strangulation of a portion of the circumference of the gut in a femoral hernia (Richter's hernia). The strangled part is rough from exuded lymph, and black (gangrenous in places).

rapidity of gut owing to the absence of putrefactive organisms. Strangulation of omentum may cause very similar signs to those shown when gut is thus affected. The cause of this is not very clear, since merely tying off omentum produces no such effect. It is assumed that in these cases the omentum drags on the colon and so causes obstruction, or that the effect is reflex. Where the condition of gangrene is left unrelieved the fluid in the sac becomes dark and putrid, while rapidly spreading peritonitis may reach the abdomen, proving soon fatal. Where the neck is well shut off by adhesions inflammation of the overlying tissues takes place, the skin becoming red, œdematous and crackling, and the abscess thus formed ulcerates through on to the surface, a fæcal fistula resulting which provides natural drainage and may save the patient's life. Such termination is, however, uncommon, as death from peritonitis or toxæmia is far more usual.

Strangulation, *i.e.* the tightness of the constriction, varies much in its intensity, and as a result the time of onset of gangrene varies within wide

limits. Snaring is worst in small femoral herniæ, in which gangrene may come on inside twenty-four hours, while large umbilical herniæ may be strangulated for several days before this takes place.

Signs and Symptoms. The general signs are those of acute intestinal obstruction. The onset is usually sudden, or less often (where following obstruction of the hernia) gradual. Shock is often considerable, pain referred to the umbilicus and hernial orifice, vomiting becoming more urgent and finally fæcal ; constipation soon becomes absolute (except sometimes in cases of partial hernia). The abdomen is slack and not tender at first, but later becomes distended as the gut above the obstruction dilates, and still later tender and rigid as peritonitis develops ; while, as in obstruction, hiccough is a sign of ill-omen.

Locally the hernia becomes tense, tender, and irreducible—that is if not so before ; while the impulse on coughing is lost unless the point of obstruction is inside the sac and below the neck, when there will be an impulse in the upper part of the sac. The tenseness is due to the distension of the strangled loop and the outpouring of fluid into the sac.

The onset of gangrene is stated to be shown by a fall in temperature and cessation of pain, but this rather means that gangrene is already far advanced to the extent of perforation of the gut. Later the skin over the hernia becomes red and œdematous, then purple, black and crackling, and gives way, forming a fæcal fistula unless (as is usual) death comes first..

In old persons the signs of shock and vomiting are less severe than in the young and the onset is often more insidious, leading to the diagnosis of inflamed or obstructed hernia until the condition is far advanced and dangerous. Hence operative interference in the old is more imperative in proportion to the severity of the signs. The safe rule is to regard as strangulated every irreducible hernia which has become tense or tender, whether impulse be present or not and whatever are the general signs of obstruction.

Treatment. The main object in view is to release the strangled loop of gut and restore it to the abdomen. This can be done by postural measures, manipulation, and operation.

(1) Postural treatment is simple and often efficacious in early cases, and can always be employed while arranging for more drastic measures. The patient is placed recumbent with the foot of the bed raised on chairs. In recent cases an ice-bag may be applied to the hernia to promote vasocontraction, but after twelve hours this is better omitted, as it tends to cause venous stasis and promote the onset of gangrene. The application of this method not infrequently reduces strangulated herniæ (especially inguinal herniæ) after taxis has failed, since the steady, slight, but persistent effect of gravity causes the gut to come back through the ring more effectively than the greater but more spasmodic force of taxis. A hot bath forms a useful preliminary to this method by causing relaxation of the parts involved.

(2) *Taxis.* To reduce a hernia by manipulation the patient is placed on the back with the thigh on the affected side flexed in the case of inguinal

or femoral hernia, or both thighs flexed for the umbilical variety. The neck of the sac is surrounded with the fingers and thumb of the left hand to direct the course of the hernia, and pressure is made on the latter with the right hand both directly and in a rocking manner. For inguinal hernia the pressure is directed up and outward, for femoral hernia downward and inward and then backward, while for umbilical straight backward. This method must be applied with caution as there is danger of injuring the strangled gut, or even of rupturing it if great force be applied. The force which it is reasonable to apply and the time during which it is justifiable varies with the position of the hernia and the time it has been strangulated. Any hernia which has been strangulated twenty-four hours or where the signs are severe should be treated gently, and if of the femoral variety taxis is best omitted. Where the condition is one of a large inguinal or umbilical hernia only recently strangulated, considerable force may be employed for about five minutes—the force, however, being steady, nothing of a jerky nature being permissible. In the case of a femoral hernia, even when quite recent, taxis should never be forcible or prolonged. Where, in suitable cases, taxis fails to produce any result after five minutes, it will generally be safest to proceed to operative measures, viz. herniotomy, and this should be performed as soon as possible when the above methods fail. Both taxis and postural treatment may fail obviously, the hernia remaining unreduced, but taxis may be apparently successful in so far that the hernia appears to be reduced and yet the signs of intestinal obstruction may persist. There are various conditions leading to this result :

(1) The hernia may not be really reduced, as follows :

(a) The gut may be pushed into a second intraparietal sac which opens into the scrotal sac distal to the neck, so that the constriction is still present and acting. This may occur in bilocular inguinal herniæ.

(b) The sac may burst close below the neck and the contents be pushed up between the latter and the parietes.

(c) The neck may be torn from its attachments and, with the still unreduced hernia, returned to the abdomen (reduction *en bloc*). These two last varieties are due to excessive force in applying taxis, and should not occur if the manipulation be made with ordinary care.

(d) The reduction may be incomplete and a small portion of the contents escape notice, though still strangulated.

(e) The obstruction may not be at the neck of the sac but by bands or through holes in the omentum inside, or there may be volvulus of the herniated loop in addition to these, so that the mass of gut may be reduced though still obstructed.

(2) Reduction and relief of obstructing bands may be complete, but :

(a) The gut reduced may not be the obstructed portion, *i.e.* there may be internal strangulation of some other part causing the signs ; this is likely to occur from adhesions at the neck of the sac.

(b) Paralytic ileus may arise in and spread from the snared loop of gut. This is usually of infective origin from early gangrene of the loop, especially

at the part constricted, which may perforate or set up peritonitis apart from this. Imperfect reduction may be suspected when on manipulation the gut goes back without the usual gurgle. Most of these conditions can only follow reduction by taxis, but paralytic ileus may follow on herniotomy. In such cases vomiting persists and becomes more urgent, while constipation is unrelieved, though occasionally in the paralytic form diarrhœa comes on and is of grave import. Where the signs persist after reduction by taxis the hernial ring should be explored, and if the condition cannot be put right from this point laparotomy should be performed and the condition found and dealt with as described under Intestinal Obstruction.

(3) *Herniotomy.* This is an operation primarily intended to free the strangled intestine and restore it to the abdominal cavity. In most instances where the patient's condition is fair, the operation is finished by one of the radical methods described, and usually with satisfactory result.

Operation. The incision is planned so as to approach the neck of the sac and the part below this, as described later under Operations for the various Forms of Hernia. The sac is opened carefully lest gut be adherent to the sac. The gut is known by being of greater thickness than any of the layers of the sac if picked up with dissecting-forceps. The sac, when opened, is well slit up and the fluid evacuated, the contents examined ; where the contents are foul resection will usually be needed, but where merely hæmorrhagic the gut is usually viable. Before dividing the constriction the sac should be washed out with weak antiseptic, lest the contents carry infection up into the peritoneal cavity. The constriction is usually divided from within with a *hernia-knife,* which is a blunt-pointed bistoury, the cutting edge of which is reduced to half an inch, situated a quarter of an inch from its end ; the intestine is kept out of the way while this is done with a flat grooved *hernia-director.* Care must always be taken that the gut is surely out of the way before the cut is made, since the constriction may lie at some depth. Where there is real difficulty it is sometimes best to divide the constriction from outside, enlarging the incision for this purpose and dissecting down. In some instances, *e.g.* intraparietal hernia, it may be safer to perform laparotomy and divide the constriction from inside the abdomen rather than blindly divide a band in the depths of the wound without knowing of what it consists. When using the hernia-knife, the director is first pushed through the ring with the groove towards the part which is to be cut ; the gut is kept away with the forefinger of the left hand and the knife introduced on the flat and then turned so that its cutting edge is to the part which requires division.

Treatment of Contents of the Sac. Omentum is tied off just above the strangulation and divided. Strangled intestine is pulled down and carefully scrutinized, especially at the point of constriction, for local gangrene is often present here, while the bulk of the loop is viable. Many conditions of the strangled gut are found : (1) it may be purple or black but still shiny, and if the colour mostly alters to red after the constriction is relieved and the substance of the gut is resilient and peristalsis is resumed there can be

no doubt that the gut will recover well, and it may be returned to the abdominal cavity, the sac removed, and the canal closed by one of the methods of radical cure already described.

(2) The condition may be slightly worse, the gut being black, but there is some return of colour when the constriction is removed, although peristalsis does not return, while there is not the flabbiness of incipient gangrene nor any alteration in odour. In such cases recovery is probable, but as there is a chance of the gut giving way it is reduced, but the sac only partially closed and a tube placed down to the gut for two days, which will establish a track along which fæces may pass if the gut gives way. There is no need to suture the gut in position, as its paralysis and the adhesions arising about it will prevent extravasation if a track is at hand to lead away any extravasated contents. This type of case is not common in practice ; usually the gut is either certainly viable or gangrenous.

(3) The gut is gangrenous. Gangrene may be incipient or fully developed. When thoroughly gangrenous the condition hardly demands special comment —the greyish-green, stinking mass speaks for itself ; but the incipient stage is worthy of more explanation, as it may be missed and fatally damaged gut returned. Where gangrene is commencing the gut loses its sheen from desquamation of the peritoneal endothelium ; the colour may be merely black, but slight alterations of this in places, such as spots or patches of greyish or dirty yellow colour, strongly suggest the presence of gangrene ; peristalsis is lost and the gut feels flabby and lacks its normal elasticity when handled ; finally, the odour is musty and unpleasant but quite different from the penetrating stench of fully developed gangrene. These signs are characteristic of early gangrene, and resection of the gangrenous part is usually successful at this stage, but if such a condition be left gangrene will progress and the result be disastrous from perforative peritonitis ; hence the prime importance of recognizing the condition.

Partial gangrene is found as just mentioned, in the form of spots in cases of incipient gangrene, but also at the site of maximum constriction, viz. at the neck of the sac. The gut elsewhere may be in good condition, but a small spot of gangrene may lead to perforative peritonitis. To avoid this danger the loop of gut should always be pulled down and the site of constriction scrutinized. Such localized gangrene is known by the gut appearing grey or dirty yellow and feeling thin and inelastic at the point of constriction.

Treatment of Gangrenous Gut. (a) *Local Gangrene.* When occurring at the site of pressure a small gangrenous patch may be invaginated by a row of sutures picking up the peritoneum and muscular layers. For large patches, or where the patches occur as part of widespread incipient gangrene, the whole area must be excised, making the sections through gut which has a good blood-supply and is not softened.

(b) In cases of incipient gangrene the condition is tolerably early and the patient's power fairly good, so that resection offers good prospects of success. Resection and anastomosis are done as detailed under Resection

of Gangrenous Gut for Intestinal Obstruction (p. 253), taking care to drain the distended intestine above the constriction before completing the anastomosis. In most instances the operation will be concluded by closing the ends and performing a lateral anastomosis.

(c) Complete gangrene is treated in a similar manner, by excision and anastomosis, except in a few instances where the patient's condition is very bad or the surroundings do not favour an operation involving suturing, &c.

In such cases the gangrenous loop may be drained. The simplest plan is to incise the loop and let the fæces run out at will. A more cleanly and accurate method, which takes but little longer, is to divide the constriction, pull down the loop of gut, cut away the gangrenous part, and tie a Paul's tube into either end, thus draining the distended gut above. If, as is often the case, the anus thus formed is in the small gut, the patient will rapidly suffer from malnutrition, even if he recovers from the shock, &c. Therefore a second operation will be needed within a week to restore the continuity of the intestine. This method is, then, to be regarded as a last resource of desperation, for the results are not good, though some survive.

After-treatment. This is similar to that for intestinal obstruction, viz. morphia in the first twenty-four hours if there be much shock or restlessness, while saline per rectum or intravenously is most valuable, and strychnine and turpentine enemata if there be much distension. By mouth hot water only for twenty-four hours, and if all goes well the bowels are opened on the third day with castor-oil, but action of the bowels should be promoted earlier where signs of ileus supervene.

Complications. (1) Prolonged vomiting, which usually loses its fæcal character but may be very depressing, and is relieved by a stomach-wash, repeated if necessary, and placing a mustard-plaster on the epigastrium.

(2) Paralysis of intestine (paralytic ileus) is evidenced by vomiting, constipation and distension, and should be treated by strychnine, turpentine enemata, and pituitary extract ; where these fail to relieve, the abdomen should be explored, as peritonitis or other causes of obstruction may be present.

(3) Peritonitis, from the gut giving way locally at the seat of pressure (careful scrutiny will save this) or, if over-distended above the obstruction, from becoming gangrenous. Laparotomy and resection can alone save such cases, but the outlook is grave.

(4) Enteritis, which is shown by the passage of loose stools mixed with mucus and persistent vomiting. A diet of milk or albumen-water with bismuth and opium may be tried, but the prognosis is bad.

OPERATIONS FOR STRANGULATION OF SPECIAL HERNIÆ. *Inguinal Hernia.* The strangulation is usually at the neck of the sac near the internal ring, but may be at a lower point inside the sac.

Differential Diagnosis. (1) From inflammation or torsion of an un-descended testis : Either of the conditions will resemble a strangulated bubonocœle as regards local signs, viz. a tender, tense swelling with no impulse on coughing, but the signs of intestinal obstruction are not

severe, vomiting does not become fæcal, nor is constipation absolute and may not occur at all; nevertheless exploration is the wisest course in these cases also.

(2) A thick-walled, non-translucent hydrocœle extending up along the canal to the internal ring, together with intestinal obstruction from other causes, may simulate a strangulated hernia; the absence of obstruction should differentiate from a hernia, while if a hydrocœle be found on exploration it will be necessary to proceed to laparotomy, where obstruction is present.

The Operation. The incision is made obliquely over the canal and external ring, *i.e.* lower than that for a radical operation, the sac opened, and the obstruction divided by cutting up and inwards to avoid the epigastric artery should the hernia be direct, for cutting outwards would then endanger the artery. In cases where the gut is in good condition a radical closure of the canal should conclude the operation, taking care that the sac is dissected well up so that it is ligatured above the place where the incision through the neck leaves a hole in the sac. Where enterectomy is needed this may be done through the inguinal opening and the wound enlarged, if need be, before reducing the anastomosed intestine.

FEMORAL HERNIA. *Differential Diagnosis.* Inflammation of the gland in the femoral canal or thrombosis of the saphenous vein at the opening closely resemble a strangulated femoral hernia as regards local signs, but signs of obstruction are absent and fever often accompanies the former conditions. However, as obstruction may be incomplete in a case of partial enterocœle (Richter), the rule is to explore at once any tender lump coming from the femoral canal.

Operation. The incision is vertical over the femoral canal, the sac is opened, and the constriction, *i.e.* Gimbernat's ligament, divided by cutting inwards and making a few small nicks rather than one large cut, in case an abnormal obturator artery be present. Should this artery be divided the wound must be enlarged, cutting upwards through Poupart's ligament, or it is better to extend the skin-incision upward, open the inguinal canal as for Lotheisen's operation, and pick up the artery on the deep surface of Gimbernat's ligament. Where the patient's condition is good the operation may be concluded after the method of Lotheisen, but where the patient is old and debilitated it will shorten matters to suture Poupart's to Cooper's ligament with two or three sutures; the results of this procedure are by no means bad. Should excision of gangrenous gut be needful, there will be little room to reduce the anastomosed gut through the small femoral opening, and it is best to proceed as follows: Pull the loop down, crush and ligature through healthy gut on either side of the gangrenous part, and tie off the mesentery; excise the gangrenous part and oversew the ligated ends with purse-string suture. Clean out the sac and wash the latter with an antiseptic lotion. Next open the abdomen by paramedial laparotomy above the pubis and pull the two blind ends of intestine through the femoral ring and unite by lateral anastomosis. The wounds are then closed in the usual manner. In this way there is less risk of fouling the peritoneum

than if the gangrenous loop be pulled back into the abdomen before excision is performed, while the femoral canal need not be enlarged.

For umbilical hernia the procedure is similar to that described for radical cure.

To sum up, the intestine which has been strangulated should not be returned to the abdomen before it has been examined most critically to exclude the possibility of gangrene.

The sequelæ of strangulated hernia, viz. fæcal fistula, artificial anus, and stenosis of the intestine, have been described in a previous section.

CHAPTER XXIII

SURGERY OF THE RECTUM

Anatomy and Examination : Congenital Defects : Imperforate Rectum : Injuries
of the Rectum : Hæmorrhoids : Prolapse : Neuropathic Conditions : Ulceration,
Anal Fissure : Suppurative Proctitis and Periproctitis : Ischio-rectal Abscess :
Fistula in Ano : Syphilis : Stricture : New Growths.

ANATOMY.   The rectum, or terminal portion of the large intestine, extends
from the third sacral vertebra to the anus.   It is conveniently divided into
the upper part, or rectum proper, and the lower, or anal canal.

The rectum proper is again divided into two parts, upper and lower.
The upper part is covered with peritoneum on its front and sides but differs
from the pelvic colon in possessing no mesentery, while the longitudinal
coat of muscles surrounds it entirely and is not grouped in tæniæ, and the
blood-vessels (which are branches of the superior hæmorrhoidal) pass in
longitudinal loops and not in the circular manner found in the colon.   The
lower, or non-peritoneal part of the rectum proper, differs from the upper
in being developed from the post-allantoic gut ; the blood-supply is con-
veyed along smaller vessels in the substance of the muscular coat, the
mucosa is in longitudinal folds, and the lumen is compressed laterally by
the levator ani muscle.   This part is of importance because it may not be
developed, leading to one form of imperforate anus.

The anal canal is surrounded all its length by the internal sphincter
and at its termination by the external sphincter.   Its mucosa is in many
small longitudinal folds (columns of Morgagni) in its upper half ; these
unite together towards the orifice to form the anal valves, which mark the
junction of the skin and mucosa ; this junction is whitish in colour and
is known as Hilton's white line.   The valves of Houston are large oblique
folds of the mucosa of the rectum proper and are usually three in number,
and possibly offer difficulty to the passage of instruments, such as the
sigmoidoscope.   The main blood-supply is from the superior hæmorrhoidal
branch of the inferior mesenteric artery, which runs down in the submucosa
as far as the anal valves, where it forms a rich plexus.   The middle and
inferior hæmorrhoidal arteries, derived from the internal iliac and pubic
arteries respectively, chiefly supply the sphincters and levator ani but also
contribute to the plexus in the lower part of the rectal mucosa.   The superior
hæmorrhoidal supplies muscles and mucosa above but only mucosa below.
There is an abundant plexus of submucous venous sinuses just above the
anal valves (dilatation of which forms hæmorrhoids).   These drain along
the internal or submucous plexus into the superior hæmorrhoidal vein.

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Passing through the muscular coat of the rectum are communicating veins which unite outside the rectum to form an external plexus, which drains into the upper, middle, and lower hæmorrhoidal veins and places them all in connexion. The lymphatic drainage is twofold. The anal canal has a lymphatic plexus which drains into the oblique set of inguinal glands. The rectum proper and the upper part of the anal canal drain by submucous plexuses into the rectal glands lying along the superior hæmorrhoidal vein, and so to the sacral and inferior mesenteric glands, but some join the internal iliac glands.

EXAMINATION OF THE RECTUM. In the first place, inquiry must be made into the functions of the rectum as regards history of pain, its relation to defæcation, the passage of blood or pus ; examination of motions and distinction of blood from the upper bowel (melæna) from that coming from the lower bowel or rectum, in which case it is liquid or clotted but otherwise unaltered. Note is also taken of frequency of defæcation, of tenesmus (frequent and painful defæcation with little or no result). Finally, it is important to note that symptoms pointing to disease of the organs of the upper abdomen may be due to rectal disease (as in dyspepsia due to cancer of the rectum), and to distinguish diarrhœa due to diet from that depending on malignant disease of the lower bowel.

Physically the rectum may be examined by sight or touch, the latter being more simple and readily managed, but vision is often useful in the more difficult conditions. In all cases the rectum should be emptied with an enema some hours before examination if the latter is to be satisfactory.

The patient may be in the knee-elbow position, in the left lateral, or even in the dorsal with the right thigh well flexed. The former gives the best opportunity for examining the surrounding perineum, but the latter are serviceable where the patient is very ill, as when examining for pelvic abscess, &c.

Digital Examination. The anointed finger is introduced into the anal canal, the patient being asked to strain. Where there is a painful fissure the patient resents even the approach of the finger and attempts at introduction cause intense agony. This sensitiveness is almost pathognomonic of painful fissure, and anæsthesia must be employed for further investigation and treatment of such a case. With the finger in the anal canal, the tissues lying between the interior of the canal and the skin should be gently palpated between the finger and thumb ; in this way the induration of fistulæ or the linear ulceration of fissures can readily be made out. Most affections of the rectum occur in the lowest inch, *i.e.* in the anal canal, and this part should be thoroughly examined before proceeding further.

The finger is then passed into the rectum proper, noting in the male the prostate, the vesiculæ seminales, and rarely the ureters in front, while in the female the os uteri will be felt projecting back through the rectal wall at a somewhat higher level or, if the organ be retroverted, the fundus uteri may be felt. The wall of the rectum should be felt all round for stricture, œdema, polypi, ulcers, especially the induration of a cancerous

ulcer, and may be hooked down with the finger (assisted by straining on the part of the patient) so that higher portions may be reached than might be expected to be possible after the rectum is removed from the body. Finally, attention is turned to the recto-vesical or recto-uterine pouch, which may contain inflammatory peritoneal exudate or secondary nodes of cancer, forming a mass of varying consistency reaching above the prostate and bladder or os uteri.

Introduction of the whole hand under anæsthesia is inadmissible, being likely to tear the rectum or paralyze the sphincter.

Visual Examination. The most useful instrument is the sigmoidoscope, which permits examination of the lower part of the sigmoid as well as of the rectum. This consists of a tube-speculum, introduced with an obturator at its end, through the anal canal. The interior is lighted with a small lamp at the extremity or by light reflected down from outside. The tube, which is of an inch and a quarter bore, is covered with a glass plate at its outer extremity, and may be inflated with air so that the rectum is kept inflated as the tube is gradually inserted, and thus any risk of tearing the mucosa avoided. In an easy rectum the tube may be introduced in this manner for a foot or more. It will be noted that the instrument should on no account be introduced more than an inch except under guidance of vision, as serious laceration of the rectum even into the peritoneum has occurred from pushing the instrument blindly upwards, since the rectum tears easily. With this instrument strictures, ulcerations, polypi, &c., above the reach of the finger may be seen. Where a sigmoidoscope is not to hand the lower rectum may be inspected with a small Ferguson's tubular vaginal speculum after stretching the anal canal and placing the patient in the knee-elbow position so that the viscera fall out of the pelvis and cause the rectum to become distended with air.

CONGENITAL DEFECTS OF THE RECTUM AND ANUS. Several varieties of this defect occur, and a few words on the manner of development of the rectum will make the conditions more easy of apprehension. At an early period of fœtal life the hind gut or upper rectum, the urethra and vagina in the female, all open into a common cavity, the cloaca. Then a protrusion of the hind gut arises called the *post-allantoic gut,* which grows backward and is joined by an invagination of the epiblast of the perineum, called the *proctodæum :* the post-allantoic gut becomes the lower, non-peritoneal part of the rectum proper, while the proctodæum forms the anal canal, and the opening of the hind gut into the cloaca closes, so that the latter becomes the upper urethra in the male and the urethra and vagina in the female. Failure of proper development of the post-allantoic gut accounts for a large number of instances of imperforate rectum and anus.

The following varieties are described :

(1) *Imperforate Anus.* In this condition there is a failure of the proctodæum or anal canal to join the post-allantoic gut. The proctodæum may be represented by a short anal canal ending blindly at a transverse septum, or may be absent altogether. The presence of the post-allantoic gut, *i.e.*

the part of the rectum below the peritoneum, is shown by a marked bulging of the perineum when the infant cries.

(2) *Imperforate Rectum.* In this condition the post-allantoic gut does not develop and the rectum ends at the lower end of the peritoneal reflection, either (*a*) blindly, being cut off from the primitive cloaca, or (*b*) the latter may persist in a stenosed condition, the result being that the rectum opens into the vagina in the female or the urethra in the male. The anal canal may be present or absent in this condition. As the rectum is thus oblite-rated fairly high up, there is but little, if any, bulging of the perineum when the infant cries.

(3) *Atresia, or Narrowing of the Large Intestine.* The colon may end at the pelvic brim or be narrowed throughout its extent, while in some instances the part of the small intestine between the cæcum and
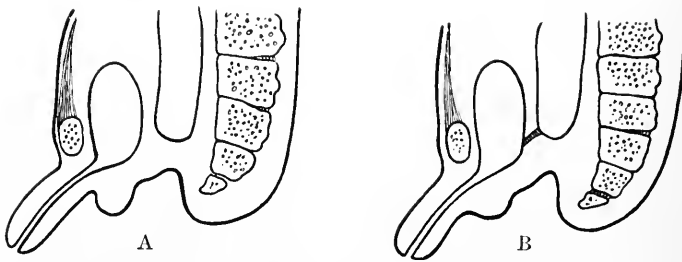
Fig. 98. A, Imperforate anus, low down from failure of the proctodæum to develop. B, Imperforate rectum higher up from failure of the post-allantoic gut to develop; the original cloaca is indicated as partially persisting and opening into the base of the bladder.

Meckel's diverticulum (Vitelline duct) is also narrowed. In such cases there may or may not be a proctodæum and there will be no bulging of the perineum on crying.

(4) The rectum may be greatly narrowed, though not completely occluded at the junction of the proctodæum with the post-allantoic gut or higher up, leading to dilatation of the colon with fæces and giving rise to some cases of idiopathic dilatation of the colon.

Diagnosis. Every infant should be examined at birth for such defects as imperforate anus, cleft-palate, &c., and if an anus be present and yet the bowels remain unopened after three days the rectum should be examined with the finger, when the obstruction will generally be felt. If the condition be not relieved signs of obstruction of the bowel (abdominal distension, vomiting, &c.) will arise.

Treatment. This should be at the earliest possible moment.

Where there is a bulging in the perineum on crying the obstruction is almost certainly in the post-allantoic gut or at its junction with the proctodæum, and can be reached by dissecting from the perineum. An incision is made from the central point of the perineum to the coccyx and a dissection carried up in the hollow of the sacrum (a sound in the urethra of the male or vagina of the female will help in avoiding these parts);

when the rectum is found it is opened, the edges sewn to the skin, and later kept dilated with bougies, as there is some tendency for contraction to take place during the first few months. This method is feasible in the two varieties first described. Where there are no signs of the rectum after the dissection has been carried up two inches into the perineum the affection is probably due to atresia of the colon high up, and the abdomen should be opened and an artificial anus formed at the lowest point where the gut is patent.

INJURIES OF THE RECTUM. These are not common and arise from various causes.

(1) Impalement accidents, as where the patient sits forcibly on the upturned leg of a chair or on a stake. Misfortunes with the sigmoidoscope or rectal bougies come under this heading, the rectum being penetrated from within.

(2) Another similar cause has arisen since the introduction of highly compressed gas in cylinders for industrial purposes. For a joke the nozzle of a cylinder has been applied to the anal region of a comrade and the tap turned on. The results have been disastrous : the sudden rush of gas forces the anal sphincter and splits the rectum even when directed through the clothes.

(3) In other instances the rectum is penetrated by injuries from outside, as happens in cases of fractured pelvis or gunshot injuries.

Signs. These are shock, bleeding from the rectum, tenesmus, possibly the escape of bowel from the rectum where the peritoneal part has been completely torn, and later peritonitis or pelvic cellulitis from escape of fæces.

The diagnosis is made by digital and visual examination, using the sigmoidoscope in doubtful cases, since early diagnosis and operation are the only hope should the peritoneum be penetrated.

Treatment. In most instances the rupture is intraperitoneal, and laparotomy should be performed, the intestines cleansed from fæces, and the wounded rectum sutured with two layers of stitches ; drainage should be employed where there has been much soiling. Where the wound is into the pelvic cellular tissues the anus should be well dilated, the wound cleansed and sutured, and if infection seems probable, drainage made by passing a tube from the perineum behind the rectum to the affected part. A tube in the rectum will allow flatus to escape for the first three days, after which the bowels may be moved with castor-oil unless peritonitis occurs, when earlier opening is essential.

HÆMORRHOIDS OR PILES. By these terms is meant a varicose condition of the veins of the anal canal and lower rectum, chiefly those of the internal hæmorrhoidal plexus.

Causes. As in varicose veins elsewhere, a congenital deficiency of the wall of the veins is an important predisposing cause, *i.e.* the veins are made of poor material. In addition the following factors assist :

(1) The act of defæcation and straining, which often accompanies this, exposes the veins to an increased internal pressure, and as there is some

eversion of the anus during defæcation the outer surface of the hæmorrhoidal veins is unsupported, and thus differs from the rest of the intra-abdominal veins. Hence straining and the constipation which leads to it are to be avoided.

(2) There are several causes leading to impaired venous return :

(*a*) Strictures of the rectum both fibrous and cancerous, which compress the veins higher up.

(*b*) Rapidly growing intra-abdominal tumours, of which pregnancy is the best example, raise the intra-abdominal, and with it the venous pressure.

(*c*) Blocking of the portal vein by a tumour at the portal hilum, or of its tributaries by cirrhosis of the liver.

(*d*) A sedentary life and constipation tend to produce stagnation of the blood in the portal system.

All these causes tend to produce dilatation of the unsupported veins of the hæmorrhoidal plexus.

The fact that the portal and systemic veins anastomose at the hæmorrhoidal plexus is sometimes given as another reason, but it seems more reasonable to regard the possibility of blood flowing into the iliac veins as a safety-valve where the portal system is engorged, and if this anastomosis were not present piles would probably be more common and worse than at present.

CLINICAL COURSE. Where the varicose veins are inside the anal canal the condition is known as internal hæmorrhoids, but those of the skin outside are known as external hæmorrhoids.

Piles may exist to a slight degree without producing any ill effects, or at most slight irritation or pricking lasting a few days, due to minute patches of phlebitis and thrombosis in some of the smaller veins. Such slight attacks are a warning to adopt a better rectal hygiene. Constipation should be avoided by suitable diet or laxatives and abdominal exercises, and a daily evacuation of the bowel should be arranged, preferably before the morning bath is taken ; hence the desirability of the Eastern custom of taking a cup of tea before rising and having a bath after the bowels have acted (not an easy habit to acquire in later years). Thus the anal margin is clean throughout the day and chances of infection diminished. Cleansing the anus after defæcation should be done with the softest toilet-paper ; scrubbing with newspaper or other forms of irritant is unpardonable and carries its own punishment.

Both external and internal piles may become inflamed or thrombosed, and internal piles may in addition cause trouble by prolapse or bleeding. Inflammation or thrombosis of piles is popularly known as " an attack of piles."

EXTERNAL PILES. These consist of dilated veins under the skin of the muco-cutaneous junction, over which the skin is thickened by previous minor attacks of inflammation. This condition produces no symptoms beyond occasional itching unless inflamed. Inflammation of piles is generally attributed to cold, but is probably always due to infection following

improper rectal hygiene, slight scratches of the delicate skin affording ingress to infective organisms.

Signs. The patient notices a pricking about the anus, and on examination the inflamed pile is found to be enlarged, hard and tender, and if large may render walking painful.

Diagnosis. The condition most often mistaken for inflamed external piles is that of condylomata of the circum-anal region. The sodden epithelium, absence of varicosity, the symmetry, and far less painful nature of the latter condition should serve to distinguish.

Treatment. The slighter cases require merely measures of rectal hygiene, viz. avoiding constipation, keeping the part clean, avoiding irritation with hard paper, and applying hazeline ointment after defæcation and cleansing the anal orifice. Where the pile is very large and tender it is a good plan to incise under local anæsthesia, turn out the clot, pare away the edges of the resulting cavity, and dress aseptically.

Also, where internal piles are removed by operation it is well freely to remove external piles, or tags of skin are liable to remain which are easily irritated and become inflamed. After several attacks of inflammation external piles are converted by fibrosis into fleshy tags, which if troublesome should be excised.

INTERNAL PILES. These are dilated, submucous veins within the anal canal, and are imperceptible to the examining finger owing to their softness unless they have been inflamed, when they may be felt as fleshy, irregular prominences inside the lower rectum. In appearance these piles vary : they may form (*a*) purple masses where the varicose veins are large and below the mucosa, or (*b*) where the smaller venules of the mucosa are dilated as well, they are of brighter colour and bleed readily owing to the ease with which small ulcers form and perforate the superficial venules. The first variety may attain a considerable size without causing any signs, but the second variety soon cause bleeding when the bowels act, which may be considerable and lead to severe anæmia.

The following secondary changes occur in internal piles : *inflammation, gangrene, protrusion.*

Inflammation. This is due to local infection, whether by scratching with hard fæces or improper efforts at cleansing. An inflamed pile soon becomes thrombosed and is painful, tender, swollen, and hard.

Gangrene may arise from the severity of the infection, but more often from prolapse of the inflamed pile through the sphincter ani, owing to the tenesmus set up by the tenderness and the strangulation of the prolapsed pile by the contraction of the sphincter, destroying the already impaired blood-supply.

Prolapse. This will only result when the pile has attained a certain size, in which case it is extruded through the anus during defæcation and is gripped by the sphincter, causing discomfort till it is returned. This may occur while the pile is not inflamed, but is more common where the latter is thrombosed and inflamed owing to the larger size and increased

irritability. If allowed to persist the prolapse becomes permanent, with weakness of the sphincter, irritation, and discharge from the surface of the extruded pile. While not inflamed, prolapsed piles can as a rule be easily replaced, but are apt to come down again and cause trouble from the discharge of mucus thus set up, and also are more prone to inflammation. Prolapse of an inflamed pile is likely to be followed by strangulation and gangrene of the part. The continued dragging of a prolapsed pile will ultimately lead to *prolapse* of the mucosa of the rectum, and in time the whole thickness of the rectal wall will protrude.

Finally, inflamed, thrombosed, and gangrenous piles may lead to general infection by embolism. The path of emboli is chiefly along the superior hæmorrhoidal vein to the portal vein and liver, thus giving rise to pyæmic abscesses of the latter or " portal pyæmia."

Diagnosis. Where bleeding is the main result the patient may be very anæmic and complain of breathlessness, faintness, and be markedly pale and even lemon-coloured, and should he fail to note that bleeding from the rectum is taking place, may be considered to be suffering from some form of " essential anæmia." Hence in all cases of obscure anæmia an examination should be made for hæmorrhoids, and it should be remembered that these are usually not to be appreciated with the finger, but the anus must be gently dilated and the mucosa pulled down till the piles are found or examination made with the sigmoidoscope. The difference between melæna or blood derived from the upper part of the bowel and that from the colon or rectum has already been detailed, and it is the latter form which comes from bleeding piles.

From prolapse of the rectum piles are distinguished by their irregular varicose shape and purple colour, but the two conditions may occur together.

From rectal polypus piles are distinguished by their softness (unless inflamed), purple colour and irregular shape, lower and sessile situation ; while a polypus is firm, red, and often pedunculated.

From cancer of the rectum the softness, lack of ulceration and infiltration of surroundings readily distinguish, but it must be pointed out that piles may owe their formation to venous obstruction at a point of the rectum higher up owing to cancer there ; hence before operating on piles the rectum above should be examined as high as possible, especially where they come on suddenly in middle-aged persons.

The difference from condylomata has already been mentioned.

Treatment. This should be palliative where the signs are slight, such as mild pruritus or feeling of weight in the rectum, where the underlying cause will soon cease to act (as in pregnancy), or where piles are merely an incident in some more serious affection, such as cancer of the rectum or cirrhosis of the liver ; nevertheless in the latter condition operative measures may be advisable where the bleeding is severe or strangulation and gangrene of the piles occur, if the general state of the patient be not too grave.

Palliative Treatment. This consists in the ordinary measures of hygiene already mentioned, special care being taken to promote an easy action of the

bowels and avoiding any straining. Cascara or salines such as Hunyadi János are suitable, while confection of senna is an old favourite and very useful.

Abstention from alcohol and highly seasoned food is advisable, and regular exercise of the abdominal muscles and diaphragm is most important. In addition to these general measures local treatment will be of much assistance ; hazeline ointment pushed well up into the anal canal night and morning after defæcation will add to the comfort, and hazeline lotion injected may temporarily check bleeding. Such measures will relieve the minor forms or where the affection is likely to be of short duration (*e.g.* in pregnancy), but in a very large number of instances removal of the offending veins is the best treatment.

INDICATIONS FOR OPERATIONS ON PILES. (1) Mere bulk of the mass of varicose veins with prolapse, pain and discharge, and attacks of inflammation.

(2) Attacks of severe inflammation likely to result in gangrene are cut short by removal of the piles, thus removing a focus of infection and perhaps saving the patient from portal pyæmia.

(3) Gangrene is another indication, for the same reasons.

(4) Bleeding, when associated with pain and prolapse or of such severity as to render the patient anæmic, should be treated by removal of the piles ; but where the bleeding is trifling palliative measures may be tried for a while.

Preparation for Operation. The bowels should be thoroughly emptied by giving an aperient two nights before and an enema the next morning, another aperient the night before followed by a second enema, which should be given at least six hours before the operation, or it may be in part retained and come away during the operation, to the great discomfort of the surgeon.

The patient is in the lithotomy position or on the left side with the right thigh well flexed and the buttock on that drawn up by the assistant. The anal sphincter is slowly dilated by inserting the thumbs and separating them till the sphincter feels slack. There are several methods of removing piles suitable to different types of cases :

(1) *Ligature.* This method has the merits of respectable antiquity, safety and speed, being therefore suitable for feeble, anæmic patients who are not good subjects for anæsthesia or more prolonged operations, since three or four clumps of piles can be removed in as many minutes.

After dilatation of the anus the piles are pulled down with forceps and with blunt-pointed scissors an incision commenced at the anal margin or slightly outside this, surrounding the pile in its lower two-thirds. The pile is quickly dissected up with snips of the scissors, exposing the external sphincter till the pile is adherent only by its upper extremity of mucous and submucous tissues. As the main vessels run down in the submucosa this can be readily effected with but little bleeding. The pile thus partially removed is firmly tied round its base with strong silk or catgut and excised, leaving a good piece of the pile beyond the ligature so that the latter does

not slip off. The other piles are treated in a similar manner, any bleeding-points secured, and where there is time the mucosa sewn to the skin on either side of the ligatured piles to promote primary union. A wide drain-tube surrounded with gauze is placed in the rectum to permit exit of flatus and to detect escape of blood, for if this be not done and a ligature slips, a large hæmorrhage into the rectum may be unnoticed till the patient becomes faint and restless, while the tube allows it to be detected earlier if the dressing be occasionally inspected by the nurse. This should be done frequently during the first twelve hours, for although the operation is a simple matter, it may prove very dangerous should a ligature slip. Morphia should be given hypodermically as the patient comes round and suffers pain. Suppositories are a crude method of administering the drug, as the latter may not be absorbed if there is much oozing into the rectum, and the dosage is thus uncertain ; the hypodermic method is far more rational and accurate.
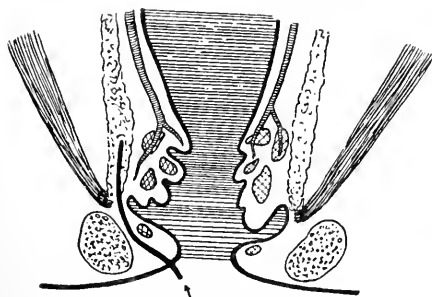
FIG. 99. Diagrammatic section of the rectum, showing the incision for the removal of hæmorrhoids, and how the main blood-supply coming from above is only divided late in the operation (the incision should not trench on the internal sphincter as shown).

The wound is dressed in twenty-four hours and the tube removed, the bowels opened on the third day, and the anus dressed daily. After a week the anus should be examined, and if any tags of skin be left these are trimmed off under local anæsthesia. The ligatures separate in about ten days and the patient may get up in fourteen to twenty-one days after operation, the dressing being replaced by hazeline or calomel ointment.

Dangers. The possibility of bleeding has been mentioned, and should this occur the best plan is to anæsthetize the patient, dilate the anus, and suture the skin to the mucosa all round over the raw surfaces, as there may be no bleeding-points visible. Where the practitioner is short-handed the simplest resource is the " petticoated tampon," which is available for any form of bleeding from the lower rectum. A rectal bougie is pushed into the centre of a square foot of lint and the latter lashed to the point of the bougie. The latter and its lint covering are lubricated and gently inserted three inches up the rectum and gauze stuffed between the bougie and the lint till the lower rectum is filled with gauze ; the lint is tied round the bougie outside the rectum, and gentle traction on the bougie will exert pressure on any bleeding-points.

The Clamp and its Adjuncts. The piles are pulled down and a powerful crushing-clamp adjusted to its base in a longitudinal direction and screwed up tight, the pile being then shaved off ; the clamp is left on for five minutes and then removed slowly. The surface left by shaving off the pile may be seared with a cautery or oversewn with continuous catgut suture. Good results are claimed, but the method is slow, and unless oversewing be practised bleeding may take place. It is said to be less painful than ligature.

Excision (*Whitehead*). This method is advisable where the piles are large and occupy most of the mucosa of the lower rectum, especially where there is prolapse as well, since the previous methods are incomplete and leave inconvenient tags between the ligatured or clamped portions. The principle of the operation is simple, viz. to remove the whole mucosa of the lower rectum or " pile-bearing area," tie the vessels, and suture the skin to the mucosa all round the circumference. The mucosa is dissected up from the external sphincter as in the method by ligature, but all round the anus. In this way a tube or cuff of mucosa and piles is fashioned having the main vessels passing into it at its upper, attached extremity ; the main vessels are picked up and tied, the mucous cuff cut away, and the edge sutured to the skin. It is best to work from below upwards, *i.e.* from the lower to the upper edge of the anus, as there is always much obscuration of the field with blood, and it is a good plan to suture the mucosa to the skin by sections as the former is divided and the piles removed, thus saving the loss of a considerable quantity of blood, an important point in the more anæmic patients. This method gives excellent results where the piles are large but takes too long for very feeble individuals. Stricture occasionally results if the mucosa does not join on to the skin, *i.e.* if the healing is not by first intention.

The after-treatment is as for the former operations.

PROLAPSE OF THE RECTUM. Under the influence of continued straining at stool the rectal mucosa tends to prolapse through the anus. Slight protrusion is normal during the act of defæcation, but should this persist after the action is finished prolapse is present. If the process is not checked it goes on till the whole thickness of the rectal wall comes down, when the prolapse is said to be " complete." Finally, the protrusion may be so extensive that the peritoneal coat is dragged down and the rectovesical pouch is actually outside the anus—covered, of course, by the coats of the rectum. The condition is in part due to laxness of the mucosa and other coats of the rectum and partly to straining from constipation, piles, the tenesmus of dysentery, difficulty of micturition, &c.

In this country cases most usually occur in small children and are due to wasting and chronic diarrhœa ; in adults prolapsing piles are responsible. In the tropics dysentery and the general relaxed condition of the patient are contributory factors.

Signs and Diagnosis. In slight instances a ring of mucosa is noted protruding from the anus, but in advanced cases the protrusion may be some inches in length.

The surface is covered with normal mucosa at first, but later this becomes purplish from strangulation or ulcerated and thickened from chronic inflammation, which renders reduction, at first an easy matter, increasingly difficult. Severe strangulation of the prolapse may lead to gangrene and sloughing off of the whole mass, sometimes with a cure of sorts, but a more likely termination is severe infection and peritonitis. The condition is distinguished from a prolapsing polypus by its larger size and the fact that

it has a central lumen leading up it inside the rectum ; from intussusception by its mucosa being continuous with the anal skin and not separated from the latter by a deep groove, which permits the passage of a finger all round the tumour between this and the sphincter, while signs of obstruction are absent.

Treatment. In the first place the underlying cause must be removed if possible, treating wasting and diarrhœa in children, vesical calculi, strictures, enlargements of the prostate, dysentery, &c., in older patients.

Local Treatment. In early and slight cases, especially in children, the patient should be kept in bed, the bowels made to act regularly and easily without causing diarrhœa ; defæcation should always be performed in the recumbent position and the nates are kept strapped together, the strapping being changed as the bowels act and the prolapse replaced should it come down. This will cure most of the minor cases. Should the prolapse be strangulated, it should be reduced at once under anæsthesia if necessary.

Operative measures are indicated in cases of long standing or where the above treatment fails after fair trial ; the following methods are used :

(1) Where the condition is partial and consecutive to piles an operation on the lines of Whitehead's excision will be indicated.

(2) In children the excision of three or four elliptical pieces of the mucosa from the long axis of the protruded mass will lead to partial stenosis of the lower rectum and cure the condition. The same result may be caused by making four linear scars with the cautery at equidistant parts of the prolapsed mucosa.

(3) The above are suitable for minor grades, but where the whole thickness of the rectum comes down they will hardly be enough and relapse may follow. Here the prolapse may be excised and the rectum joined again by circular anastomosis, or :

(4) The abdomen may be opened and the rectum and lower sigmoid slung up by suturing to the parietes (proctopexy). This may be combined with :

(5) Through a linear incision from the anus to the coccyx the rectum is dissected away from the hollow of the sacrum as high as possible and the cavity packed with gauze for a week till granulation is well established. The gauze is then removed and the patient kept recumbent for three weeks with the foot of the bed raised, so that the rectum becomes firmly adherent to the front of the sacrum (Mummery).

NEUROPATHIC CONDITIONS OF THE RECTUM. *Pruritus Ani.* By this is meant a feeling of irritation of the anus and surrounding skin, which may be trifling or vexatious and insupportable. Usually the condition is due to some organic cause, such as piles, fistula, threadworms, eczema, dirt, &c., of which the treatment is obvious or elsewhere described, but in a small number of instances there is no discoverable cause, and these cases are the most intractable of all.

Treatment. Palliation should be attempted by regulating the bowels, applying dilute carbolic lotion or ointment containing carbolic acid or tar,

night and morning. Should these measures fail it is worth trying the effect of division of the cutaneous nerves of this region. This is done by turning up two semilunar flaps on either side of the anus, dissecting these inwards nearly to the latter and then suturing them in place again.

INFLAMMATION OF THE RECTUM AND ITS SURROUNDINGS. Under this heading are included catarrh, ulceration and suppuration, both acute and chronic.

Proctitis, or inflammation of the rectum, is usually infective, being due to spread of dysentery from above or gonorrhœa from below (in women) ; also from impaction of fæces, foreign bodies, malignant growth, &c.

The signs are pain on defæcation, a sensation of fullness of the part, tenesmus with passage of blood and mucus or pus : local examination with sigmoidoscope (unnecessary in the acute stage) will show the congested, inflamed mucosa and hyperæmic follicles or small ulcers, &c.

Treatment. Rest in bed, keeping the motions soft and giving a bland diet of milk, eggs, plenty of bland fluid ; the cause, if possible, is removed and injection of dilute lead or hazeline lotion given, with opium where the tenesmus is severe. Ulceration, periproctitis, and stricture may be later sequelæ.

FIG. 100. Diagram of a fissure in ano, or torn down valve of Morgagni, below which is a " sentinel pile."

ULCERATION OF THE RECTUM. This may be dysenteric, tuberculous, or malignant ; the last two conditions are described elsewhere ; but a most important form of ulceration, owing to its frequency and painfulness, is that occurring in the anal canal usually known as " anal fissure."

ANAL FISSURE. This condition is due to the tearing down of one of the valves of Morgagni towards the anal orifice by the passage of hard fæces. This tearing leaves a raw surface which is kept open by succeeding acts of defæcation, which further pull down the torn valve. The raw surface becomes a chronic linear ulcer and the torn valve forms an œdematous tag, protruding at the anus, known as a " sentinel pile " (quite a different structure from an ordinary pile, and really part of the edge of the ulcer which is prolapsed and œdematous). When felt with the examining finger the ulcer feels like a crack in the wall of the anal canal with indurated edges, but when the sphincter is dilated under anæsthesia it is seen to be an oval ulcer with the sentinel pile at its lower end.

Symptoms and Signs. Pain on defæcation is the usual complaint. This may be moderate or of the most excruciating nature radiating to the sacrum and legs, causing the patient to dread an action of the bowels, the result being aggravated constipation, and when this has to be relieved causing more agony. Where the pain is less, pruritus may be the main symptom. In a really painful fissure examination is impossible except under anæsthesia, and the extreme sensitiveness on attempting this suggests the diagnosis, and the advisability of anæsthesia.

Treatment. In the less painful cases, when still recent, attempts may be made to palliate the condition by keeping the motions soft with confection of senna and applying hazeline ointment to the anal canal, but where the condition is painful or of some standing the following small operation should be done.

Operation. Under ether or gas and oxygen anæsthesia the sphincter is dilated so that it is paralyzed for some hours and the painful spasm thus obviated. The ulcer is then split in its long axis down to the sphincter, which is slightly nicked ; the floor of the ulcer is curetted away and the edges, including the sentinel pile, snipped off smooth so that no projections are left in which fæces may catch. A dressing is applied and the bowels opened after three days, the patient being then allowed up and the bowels kept open freely and hazeline ointment applied to the canal. Healing and freedom from pain soon follow, and this is one of the most satisfactory of minor operations.
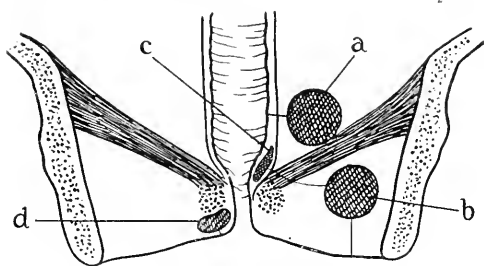
FIG. 101. Diagram of the pelvis to show the position of abscesses about the rectum, viz. *a*, above the levator ani or pelvic ; *b*, below the levator ani or ischio-rectal ; *c*, submucous in the rectum ; *d*, at the anal margin or peri-anal.

SUPPURATIVE PROCTITIS AND PERI-PROCTITIS. Several types of abscess are found in and about the wall of the rectum, and, owing to the ease with which re-infection takes place from fæcal contamination, sinuses and fistulæ are frequent sequelæ. The infections arise from the surrounding skin or the inside of the rectum from minor injuries by foreign bodies, inflamed piles, or from ulcers of the rectal mucosa, whether simple, specific, or malignant. The following varieties of abscess are described :

(1) *Submucous Abscess.* In this form the abscess lies in the wall of the rectum between the mucosa and the muscle. These seldom attain any great size and are known by causing pain on defæcation, and on examination a fluctuating swelling is felt bulging into the inside of the rectum. When such an abscess bursts into the rectum there results a " blind internal fistula."

Treatment. Such an abscess should be slit up (after dilating the sphincter) throughout its length and the overlying rotten and soft mucosa cut away freely, after which it will granulate from the bottom : if insufficiently opened there is a great chance of the fistulous tract being re-established.

(2) Inflammation and suppuration may occur outside the rectal wall and above the insertion of the levator ani. The abscess is then in the cavity of the pelvis, and may result from ulcers of the rectum or by spread from surrounding parts, *e.g.* parametritis, prostatic abscess. Such abscesses may track up into the lower abdomen and infect the pelvic peritoneum or pass through the levator ani, forming an ischio-rectal abscess.

The signs are pain on defæcation, malaise, fever, and on examination a hard or more or less boggy and fluctuating mass is felt high up in the rectum.

Treatment. These abscesses should be opened behind the anus.

(3) Suppuration may and very often does occur outside the rectum below the insertion of the levator ani muscle, *i.e.* in the ischio-rectal fossa, and such a collection is known as an " ischio-rectal abscess."

Signs. There is pain on defæcation, sitting and walking, together with the appearance of a swelling—brawny at first, later boggy, red, and extremely tender at one side of the anus, felt in the rectum and perineum, while the general signs of abscess, fever, &c., are noted.

Treatment. As soon as suppuration is definitely diagnosed the abscess should be freely opened from the perineum. The incision should be T-shaped, the stem of the letter radiating from the anus and the cross-stroke being at the most prominent part of the abscess. The incision should be kept freely opened and the cavity irrigated with hydrogen peroxide, while fomentations at first relieve the pain. Unless freely opened so that the abscess granulates from the bottom there is considerable risk of the abscess bursting into the rectum as well, and so forming a complete fistula, the healing of which is a much longer matter than that of a simple ischio-rectal abscess.

(4) In tuberculous subjects cold abscesses may develop in this situation and present similar signs to the last-mentioned condition, with the exception that the pain and redness are less marked. They are treated as cold abscesses elsewhere, taking special care to avoid contamination from the rectum, as a tuberculous fistula is very troublesome to treat.

(5) Suppuration also occurs about the anal verge, quite superficial to the sphincter, and these *peri-anal* abscesses are never of any great size and quite superficial. They also require to be opened freely, or small fistulæ may arise.

(6) Gangrenous periproctitis may occur as the result of severe infection or in weakly subjects or as the result of injury ; thus we have known this condition follow an enema delivered into the perirectal tissues. In this condition great œdema and severe constitutional disturbance arise, rendering free incisions, drainage, and irrigation with peroxide of hydrogen necessary.

FISTULÆ AND SINUSES ABOUT THE RECTUM (fistula in ano). From what has been already stated it will be understood that there is always a chance that the above forms of abscess may develop into chronic sinuses owing to deficient drainage and fæcal contamination, while the movements of the sphincters and levator ani prevent rest of the part. A sinus in this region is commonly called a fistula, whether it obviously leads from the rectum to the surface or only from one or other into the tissues. A true fistula is known as a complete fistula, while a sinus opening into the rectum is called a blind internal fistula, or if opening on the perineal surface as a blind external fistula.

Fistulæ are the result of (*a*) ischio-rectal and other peri-rectal abscesses which have burst or been opened and not healed ; (*b*) from the breaking down of tuberculous foci in the neighbourhood ; (*c*) from ulceration and suppuration above a stricture of the rectum, whether fibrous or cancerous.

Anatomy. The varieties of fistulæ depend on the type of peri-rectal abscess from which they are derived. Thus :

(*a*) A peri-anal abscess may form a small fistula opening on the skin close to the anus, and at its inner end opening into the anal canal, a short distance up and below the sphincters.

(*b*) An ischio-rectal abscess, should it result in a complete fistula, will open on the skin one or two inches from the anus and into the bowel above the external sphincter, less often above the internal sphincter.

(*c*) A submucous abscess will often lead to a blind internal fistula. Fistulæ, however, are often not simple and direct tracks from one aperture to the other but may run in a very circuitous course from one to the other. Just as in the case of acute abscesses the cavity is often not simple but leads into branching pockets, so a fistula commonly has side-tracks ramifying

Fig. 102. A, Fistula in ano of the "horse-shoe type," the black spots are the openings, the dotted lines the subcutaneous course of the fistulous tracts. B, Treatment of a "horse-shoe" fistula by slitting up the fistulous tracts and opening into the rectum only at one point.

in the perineal tissues and forming one of the main difficulties in the treatment of this condition.

(*d*) An important variety of the more severe fistulæ is known as the "horse-shoe," in which there are several fistulous openings on the skin around the anus connected by suppurating tracks following a more or less circular course about the anus, while the opening into the rectum is usually single and on the posterior aspect of the latter.

(*e*) Another important type is the "tuberculous," which follows on the breaking down of a tuberculous focus which perforates on the skin and often into the bowel as well. The fistulæ are found in the subjects of phthisis and other chronic tuberculous disease, and are characterized by less tendency to fibrosis, more abundant and weaker granulations, and they break down with superficial ulceration in a manner quite different to ordinary fistulæ in ano.

Signs. Pain and tenderness of varying degree, especially on defæcation and walking, are usual. Discharge of pus from the surface where the fistula is external, from the rectum during defæcation where the condition is internal or complete, while in the latter condition there may be a discharge of fæces on the surface but more often only of pus. In most instances the history will point to a previous ischio-rectal abscess.

Diagnosis. The external opening when present is obvious; the indurated track of the fistula can be felt when the finger is inserted into the anal canal and the surrounding perineum palpated between the finger and thumb. The internal opening, when present, is felt as a dimple at the end of the indurated track. A probe may be passed, but little more is learned from this and it may be painful. From urinary fistulæ opening on the perineum the condition is diagnosed by absence of urinary obstruction subjective or objective, nor is urine passed through the fistulous openings as in the former condition. The rectum should always be carefully examined in these cases for cancer higher up, as fistula may be secondary to this, and such cases will usually require to be treated by colostomy rather than locally.

Treatment. Operation affords the only hope of cure, and should always be undertaken where the condition of the patient permits.

Care is needed in treating tuberculous fistulæ, which can usually be distinguished by the signs just mentioned. Of course, a phthisical patient may suffer from an ordinary fistula, but where the patient is suffering with severe progressive phthisis there is but little prospect of success attending local operation, and little can be done except to keep the track clean by irrigating and the use of antiseptics, *e.g.* orthoform powder. Where the condition is very distressing a colostomy may render the remainder of life more endurable.

Local operative treatment consists in either excising the fistula in toto or in laying it thoroughly open, with its side-tracks, and allowing the wound to granulate up from the bottom, which is a very tedious affair in the major cases.

(1) Excision is only suitable for small peri-anal fistulæ or in larger forms where there are no side branches.

In the lithotomy position and after dilating the sphincter a probe is passed down the fistula and out of the anus, the fistula is slit up, and its fibrous interior dissected completely out of the surrounding tissues. The external sphincter is probably divided; this is carefully sutured with catgut, then the mucosa of the rectum is sutured, and finally the wound in the perineum closed with deep sutures of stout silkworm-gut, passing from the surface deeply so as to secure coaptation at the bottom of the wound. The bowels are opened about the third day, and if healing occur the patient is cured in ten days. Often, however, side channels are missed and the condition recurs. Mackenzie describes an improvement on this method suitable for " horse-shoe fistulæ." The part of the fistula opening into the rectum is dissected out of the wall of the latter and the aperture thus formed closed; then a large wedge-shaped flap is reflected with its apex partially surrounding the anus and its much larger base out on the buttock embracing all the fistulous openings. The fistulous tracks are dissected out of the under-surface of the flap and the latter sutured back in position; good results and rapid healing are claimed.

(2) The main fistula is laid open into the rectum and all branches are

laid open to the perineum, tracing the latter carefully in all directions; in severe cases the perineum is much intersected by these incisions. The wounds are packed with gauze, dressed and irrigated daily, or oftener at first. The secret of success is careful dressing and maintaining asepsis after large operations of this type : months may elapse before healing results.

In the more extensive fistulæ the incision into the rectum should only be made on one place and not opposite the external openings all round, for if the sphincter be cut in more than one place permanent incontinence of fæces may result. Thus in a case of horse-shoe fistula the anus will be largely surrounded by an incision passing from the perineum to the side channels, but the latter will only pass into the rectum at the back where the main internal opening is situated.

In a few instances blind external fistulæ may be cured by opening freely from the perineum without dividing the rectum, but many apparent external fistulæ are really complete, with a very small internal opening. Blind internal fistulæ are slit up after stretching the sphincter and the diseased superadjacent mucosa is cut away ; hæmorrhage is to be expected in these cases, rendering plugging with gauze necessary.

Results of Fistulæ. Where the sphincters are hopelessly tied up in fibrous tissue, as may happen after operations on very large and chronic fistulæ, incontinence of fæces may result, rendering colostomy needful. On the other hand, the contraction of the scar after a fistula heals may lead to stenosis, rendering necessary the passage of bougies.

TUBERCULOSIS OF THE RECTUM. Attention has already been drawn to tuberculous fistulæ which arise from tuberculous periproctitis or tuberculous ulceration of the rectum, leading to perforation.

Treatment is usually palliative owing to the general condition of the patient. In favourable cases excision of the ulcer or fistula may be possible, while for the more aggravated cases the possibility of colostomy should be borne in mind.

SYPHILIS OF THE RECTUM. Rarely a primary chancre may be found at the anal margin. In secondary syphilis condylomata of this region are common, resulting from overgrowth of the specific papules. The diagnosis from piles has been already mentioned. The symmetrical distribution-covering of sodden epithelium and tendency to become papillomatous as they increase in chronicity serves to distinguish the syphilitic lesion.

Treatment is antisyphilitic, and dusting with calomel and boric powder locally.

In tertiary syphilis leucoplakia of the anus may occur, as on the tongue, glans penis, &c., and may also pass into epithelioma.

Gummatous infiltration of the rectum is also found, usually in young women, leading to ulceration and stenosis of the rectum and sometimes fistulæ. It is questionable if this condition is not in many instances really the result of gonorrhoeal proctitis, since the infection from the vagina to the rectum is an easy matter in women and the condition is far more common in the sex.

Signs. Painful defæcation, the passage of blood, mucus and pus, together with a condition locally of stenosis and ulceration of the hypertrophic type occurring in a female below middle age, is almost certainly this condition.

Treatment. Where the condition is syphilitic treatment for this disease is indicated. Local treatment on antiseptic lines, washing out, &c., may cure in the earlier stages, but where inveterate, with stenosis and fistulæ, colostomy is indicated, which may be temporary till the lesion is healed, but often will need to be permanent owing to the amount of stenosis resulting.

STRICTURE OF THE RECTUM. Narrowing of the rectum may result from the fibrosis consequent on inflammation (simple or fibrous stricture), or be due to cancer ; the latter is discussed in an earlier chapter (p. 227, vol. ii).

Fibrous stricture may be due to many causes ; the commonest form follows on the condition last described of syphilitic or gonorrhœal proctitis, usually in women. Dysenteric ulceration, pelvic cellulitis, contraction around fistulæ, and the results of inflammation or operations on piles, account for some examples.

Signs. In the common form the patient complains of difficulty of defæcation, with pain, often an alternation of diarrhœa and constipation and passage of blood and mucus, while later the motions become narrowed and signs of intestinal obstruction are noted.

On examination the stricture is usually found within two to three inches of the anus, but may be out of reach of the finger and only visible with the sigmoidoscope. The stricture is most commonly of the annular variety, *i.e.* smooth with a thin edge, quite different from the hypertrophic, indurated, rolled, fungating edge of a cancer. Above the stricture the gut is dilated and hypertrophied as usual, but below often ulcerated and fibrosed with polypoid excrescences, and this forms a distinction from a cancerous stricture, in which the gut below the stenosis is typically normal.

Where the stricture is due to pelvic cellulitis, fistulæ, &c., it may be irregular and elongate, the fistulous tracts about it being characteristic. The diagnosis from cancer is usually easy, bearing in mind the points just mentioned, but where there is hypertrophic ulceration associated with stricture it may be impossible without microscopical examination to decide the matter.

Treatment. In the early stages the motions should be kept soft and the ulcers cleaned by antiseptic irrigation, while the stricture is dilated with bougies. This should be done with the greatest care, as the ulcerated rectum is very easily torn and with it the peritoneum, leading to severe and possibly fatal peritonitis. At the same time, where the patient is syphilitic, salvarsan, iodides, and mercury are given.

Where the stricture is too tight to admit bougies or contracts rapidly in spite of dilatation it should be divided from within (posterior proctotomy), cutting backwards towards the sacrum : the incision is packed with gauze and passage of bougies commenced again in about five days.

Where the stricture cannot be reached or rebels against the above treatment it should be excised, and if possible the continuity of the rectum restored again by anastomosis, leaving the sphincters intact. But as this may prove impossible the final opening of the bowel may have to be through a colostomy.

TUMOURS OF THE RECTUM. Rectal polypus is common in children and consists of a pedunculated growth, usually an adenoma of the columnar-celled mucous crypts, or a fibroma. The signs are passage of blood with the motions, tenesmus, and sometimes prolapse of the rectum.

Diagnosis. The condition is distinguished from intussusception by the absence of severe symptoms and by feeling the polypus per rectum, which is not always an easy matter, since they are elusive objects (usually about the size of a large pea) and easily confused with scybala unless the rectum be well emptied.

Treatment. A ligature round the pedicle and excision. Multiple polypi are of less common occurrence and also found in young persons. The signs are discharge of blood and mucus with tenesmus. These may be excised locally but may extend into the pelvic colon out of reach. In such cases excision of the lower colon lends the best prospect of success.

Papillomas or villous growths are cauliflower-like masses, rarely found, growing in the rectum ; they tend to malignancy, and should be removed freely. Sarcoma is another rare tumour arising as a submucous tumour projecting into the bowel. A thorough extirpation of the rectum on the lines laid down for cancer is the only hope where not too far advanced.

Cancer of the rectum is described under Affections of the Large Intestine (p. 227, vol. ii).

CHAPTER XXIV

SURGICAL GYNÆCOLOGY

Anatomy : Ectopic Gestation : Puerperal Infections : Peritoneal Infections :
Pelvic Cellulitis : Salpingitis : Pyosalpinx : Ovarian Tumours : Complications :
Broad Ligament Cysts : Uterine Fibroids : Cancer of the Uterus : Operations.

In this section are discussed only those affections of the female genitalia
which are likely to come under the notice of a general surgeon either from
difficulties in diagnosis or on account of their urgency.

ANATOMY. The broad ligament lies transversely across the pelvis
between the bladder and rectum, the peritoneal covering of these organs

FIG. 103. Sagittal section of the female pelvis seen from above, showing the
relation of the ureter to the cervix uteri and of the vagina to the pouch of Douglas.

being reflected over the ligament. Below and at its extremities the broad
ligament is continuous with the cellular tissue of the pelvic floor and walls,
above in its free margin lie the Fallopian tubes. The uterus is situated
in the median portion of the ligament, the Fallopian tubes leading outwards
from its upper angles, to end at their fimbriated extremities close to the
pelvic wall. The ovary is slung from the posterior surface of the broad

ligament by a fold of peritoneum, and normally lies in a fossa in the lateral wall of the pelvis, formed by the angle of divergence of the external and internal iliac arteries. In the broad ligament close to the ovarian mesentery is the parovarium, a relic of the mesonephros (homologous with the epididymis of the male) which gives rise to some forms of " broad-ligament cysts." The lower end or cervix of the uterus projects into the vagina, and the peritoneum covers the posterior fornix of the latter, so that the peritoneal is separated from the vaginal cavity by less than a quarter of an inch of tissue, and the former may readily be opened at this point either by insertion of foreign bodies or as a surgical measure for establishing drainage of the lower abdomen. An important relation of the cervix uteri in the broad ligament is the ureter, which passes at the side of the former, as it runs to the bladder. The blood-supply to the ovary from the aorta, and to the uterus and vagina from the internal iliac arteries, also reach their destination in the broad ligament.

The following conditions will be considered : ectopic gestation, infections of the uterus and Fallopian tubes, tumours and cysts of the uterus, broad ligaments, and ovaries.

ECTOPIC GESTATION

Development of the fertilized ovum normally takes place inside the body of the uterus, but occasionally it may occur (1) in the Fallopian tube, (2) in the horn of a bicorned uterus, (3) at the junction of the tube with the uterus (interstitial), or (4) very rarely on the surface of the ovary. When taking place in any of the latter situations the condition is known as an ectopic gestation and is likely to lead to serious complications, since the surface on which the ovum develops cannot in the latter instances hypertrophy in a degree commensurate with the growth of the ovum, as is the case with the body of the uterus. In the case of ectopic gestation in the Fallopian tube (the usual situation) the wall of the latter becomes thinned and may rupture with severe bleeding, or the ovum may be expelled from the fimbriated end of the tube into the abdominal cavity (tubal abortion), which also leads to severe internal hæmorrhage. In most cases the growth of the placenta and fœtus is affected by the abnormal position and hæmorrhage takes place into the ovum, which becomes full of organizing clot, and the pregnancy finishes with death of the fœtus (tubal mole). Occasionally the placenta, after rupture or tubal abortion, takes root again on the surrounding tissue, and the pregnancy goes on to term and is followed by " spurious labour." The fœtus then dies and by degrees atrophies and becomes calcified, the latter condition being known as a " lithopædion."

During such a pregnancy the uterus hypertrophies both as regards its muscular wall and its mucosa as in normal pregnancy, the latter forming a decidual membrane, but of course of less magnitude than that formed when the pregnancy is in the uterine body. The hæmorrhages which occur, may escape from the uterus and lead to irregular bleeding during early pregnancy.

Where the tube ruptures this may be (*a*) into the peritoneum, in which case there is usually great internal hæmorrhage, or (*b*) into the broad ligament, in which case the bleeding naturally cannot be so severe but is contained in the ligament and forms a mass which pushes the uterus over to the other side.   Rupture of an ectopic gestation or tubal abortion usually takes place in the first three months of pregnancy, often within six weeks. Ectopic gestation may sometimes be diagnosed, or shrewdly suspected, before rupture takes place, but more commonly either (*a*) the first warning is severe internal bleeding or (*b*) moderate bleeding takes place with the formation of a " pelvic hæmatocœle " or collection of liquid and clotted blood in the pelvis, more or less surrounded by adhesions.

Signs of Ectopic Pregnancy.   The condition may occur in the first pregnancy, but is more usual where one or more normal pregnancies have already taken place, and often when some interval has elapsed since the last pregnancy, and very often where there has been some disease of the Fallopian tubes. In most instances a menstrual period is missed and then the patient suffers with irregular pains in the lower abdomen, and irregular uterine hæmorrhages which may be mistaken for irregular menstruation.   With the hæmorrhage a cast of uterine decidua may be passed which is very suggestive of ectopic gestation.   If a patient be examined at this stage the uterus will be slightly enlarged and a swelling will be noted in one fornix, which is the tubal gestation.   Very often, however, the patient will regard the pain and bleeding simply as due to irregular and painful menstruation, till the final catastrophe takes place and the tube bursts or tubal abortion takes place.   In the more urgent cases the patient is taken with severe abdominal pain and soon becomes blanched and faint, while on examination there are marked signs of internal hæmorrhage, viz. pallor, breathlessness, syncope, a small rapid pulse and air hunger, and shifting dullness may be found in the flanks.   In cases where the bleeding is less severe the signs of hæmorrhage are less obvious and may not be noted, but the presence of a mass in Douglas's pouch, together with the abdominal pain and rise of temperature, may cause the condition to be mistaken for appendicitis. It should be noted that the cases with severe hæmorrhage may die in a few hours if not treated, while the less severe types with pelvic hæmatocœle may not come for advice for some days.

Where the tube ruptures into the broad ligament the signs will also be of relatively mild nature ;   there will be no swelling palpable from the abdomen, but per vaginam a mass will be found in the lateral fornix, and the uterus will be displaced to the opposite side.

Diagnosis.   The signs in the unruptured condition will closely resemble those of a hydro- or pyosalpinx or a small ovarian cyst complicating normal pregnancy which is about to miscarry.   The passage of a decidual membrane without fœtal contents from the uterus will distinguish between these conditions.

Gross internal bleeding has to be distinguished from other intra-peritoneal disasters, such as perforations of viscera (*e.g.* gastric, duodenal,

typhoid ulcers), acute spreading infections, *e.g.* from appendix or gall-bladder, acute intestinal obstruction. The intensely rapid advance of the signs of internal bleeding, with some abdominal pain and absence of rigidity of the abdomen, will generally render the matter clear at once (*see* Peritonitis, p 113, vol. ii). The cases most likely to lead to confusion are the less severe types of bleeding which end in the formation of hæmatocœles. These cases present signs very similar to those of appendicitis, tubal infections, and twisting of ovarian cysts. The history of irregular menstruation and uterine hæmorrhage will suggest that such a pelvic mass is a hæmatocœle and not an inflammatory collection, but in most cases exploration will be safer than expectancy. Another cause of gross internal bleeding in women is rupture of a ripe Graafian follicle, which may lead to equally severe bleeding and present the same physical signs and also is an urgent condition, demanding laparotomy.

Treatment. Where there is rupture with severe internal hæmorrhage immediate operation is indicated, nor is there any time to spare. Where the ectopic gestation is diagnosed before rupture takes place, some advocate placing the patient in bed and waiting for the pregnancy to become a " mole," of which there is a moderate probability, and this course may be correct where the patient is under close observation, as in hospital, where surgical aid can be obtained with celerity. In most instances, however, seeing that the patient is, as it were, seated on a powder magazine and if rupture takes place every hour of delay is dangerous, removal of the abnormally situated gestation seems the only correct course. Where rupture has already occurred and the bleeding happens to be slight with formation of a pelvic hæmatocœle, expectant measures may be adopted where the latter is small and not increasing. But where the hæmatocœle is large it is simpler and safer to remove it, thus obviating any risks of further bleeding or suppuration of the clot. Thus in most instances laparotomy is indicated, and when we consider that the diagnosis is often uncertain and by delaying we may leave some dangerous infective focus till too late, there remain few cases which the careful surgeon will treat on expectant lines.

Operation. (*a*) In cases of severe bleeding the abdomen is opened by a paramedial incision below the umbilicus. Enormous quantities of liquid blood escape, but no time is wasted in mopping this away as it is already outside the blood-vessels and so useless. The hand is quickly passed down into the pelvis to the uterus and the tubes traced from this in either direction till a swelling is found on one of them, which is the gestation. The affected tube is brought to the surface, the broad ligament transfixed with interlocking ligatures, which are tied on either side of the gestation, and the latter cut away. The abdomen is sponged free of blood, the other tube examined, and the abdomen closed. The operation is simple and takes but little time, and if not too much time has been lost is most successful.

Treatment for hæmorrhage, viz. saline infusion into veins, rectum, bandaging the limbs and inverting the patient, will be needed in the more ex-sanguine patients.

(*b*) For an unruptured gestation the operation is similar, but there is less need for dispatch, nor is there any blood to remove from the peritoneal cavity.

(*c*) In cases of pelvic hæmatocœle the abdomen is opened and the affected tube and clots removed ; where there is much oozing from the surface when the clot has been removed, a gauze pack may be introduced for twenty-four hours. Where the placenta has acquired a new attachment to the surroundings and the pregnancy is still continuing the treatment should be the same, as there will be more risk in removal the longer the pregnancy lasts.

INFECTIONS OF THE UTERUS AND FALLOPIAN TUBES

In most instances the spread of infection is from the vagina and os uteri inwards to the body of the uterus and tubes. The initial cause is often gonorrhœa, for although the gonococcus may not be found in the exudate of the infected organs, it has possibly died out and been replaced by some more enduring organism. Infection following abortion, labour, or operative interference may be of this nature. Tuberculosis is not uncommon and the female genitalia afford one of the starting-points for the onset of tuberculous peritonitis. Owing to the way in which the uterus and tubes are set in the cellular tissue of the broad ligament and covered with peritoneum, infection of these organs may give rise to the well-defined conditions of " pelvic cellulitis " and " pelvic peritonitis." From a practical standpoint these infections may be divided into the puerperal and the non-puerperal forms.

A. PUERPERAL INFECTIONS. These vary in virulence from mild cases where there is absorption of toxins from retained and infected blood-clot or placenta to the most rapidly fatal, infective peritonitis and general blood-borne infections.

(*a*) *Blood-borne Infections.* The milder types, sometimes described as sapræmia, may be due to absorption of toxins from the raw site of placental detachment. It is questionable to what degree blood-infection takes place in such cases, but organisms may be found in the blood and yet recovery take place, while in the more severe and fatal instances organisms are usually found in the blood. In the latter class of cases the results of infection of veins and sinuses is obvious, even on macroscopical examination, as suppurative phlebitis and thrombosis of the uterine veins. These cases clinically are characterized by general signs of infection : swinging pyrexia, anorexia, thirst, furred tongue, rapid pulse, delirium, and uterine discharge of varying degree of foulness—the latter being due to decomposition of retained clot or placenta and often being slight or absent where there is a severe infection passing into the blood or lymphatics.

Treatment. The cervix is dilated and clots or retained placenta removed from the interior of the uterus and the latter douched with dilute iodine or lysol solution. This will cure the milder forms. But where the infection has already spread to the tissue of the uterus and the veins are infected and local peritonitis or septicæmia is produced, it is a question whether the

uterus should be removed by an abdominal hysterectomy with the veins above the site of thrombosis. Successes are claimed by this drastic procedure, but considering the difficulty of accurate diagnosis and the depressed condition of the patient it will often be difficult to advise such measures, although the principle involved is just as rational as is occlusion of the lateral sinus and ligature of the jugular vein in cases of infective thrombosis of the former vessel.

(b) *Peritoneal Infections.* In puerperal cases the infection is often streptococcal, tends to be diffuse, and is rapidly fatal, rendering operative measures seldom advisable unless the effusion becomes localized, in which case drainage may be established by performing laparotomy and then passing a tube from the vagina into Douglas's pouch.

(c) *Pelvic Cellulitis.* This usually results from infection spreading into the tissues of the broad ligament, through tears of the cervix. The condition is recognized clinically by irregular pyrexia and tenderness of the lower abdomen, while on examining the pelvis per vaginam the uterus is found to be fixed by a mass in one or both lateral fornices. This condition often subsides under the expectant measures of keeping the patient in bed, removing any infective material from the interior of the uterus, and keeping it clean with intra-uterine and vaginal douches. In other instances the site of infection breaks down and suppurates, abscesses forming which track up the broad ligament to the iliac fossa and form a hard, tender mass in the latter situation in which later fluctuation may be detected. The usual practice is to treat such cases expectantly till the presence of suppuration is made clear by fluctuation, when the abscess is opened above Poupart's ligament, or through the vagina where the fluctuation is felt in either fornix.

B. Non-puerperal Infections (salpingitis, pyosalpinx). The bulk of these arise as gonorrhœal infections, though secondary infection often occurs, the gonococcus dying out ; a certain number of instances are tuberculous. In most of these conditions the brunt of the attack falls on the tubes, the uterus usually escaping with little more than a purulent catarrh of its mucosa except in tuberculous infection, when the uterus as well as the tubes may be severely involved. Infection of the tubes is likely soon to involve all coats, including the peritoneum, and the resulting local peritonitis seals off the abdominal opening (ostium) of the tube ; the opening into the uterus is naturally small and easily becomes blocked by œdema, the result being that pus or secretion collects in the tube, which becomes distended to a varying degree. The dilated tube is often shaped like a retort, the larger end impinging on and involving the ovary.

Signs. In the more acute forms the signs may be those of peritonitis of the lower abdomen, and diagnosis from appendicitis may not be easy. The history of a previous miscarriage or labour, vaginitis past or present associated with painful and irregular menstruation, a tumour in Douglas's pouch with fixity of the uterus from peritonitis, will suggest the diagnosis of tubal infection rather than appendicitis. In the less urgent cases there

will be a history of irregular and painful menstruation, pain in the pelvic region, made worse by standing or defæcation, together with some fever and constipation. Signs of peritonitis may be absent on abdominal examination and only noted when the vagina is palpated, when the tender swelling in Douglas's pouch and fixity of the uterus will be noted. In still less severe cases the enlarged, tender tubes can be felt on bimanual examination in the lateral fornices on either side of the body of the uterus.

Treatment. Gynæcologists are inclined to leave these cases to quiet down under expectant measures, rest, laxatives, hot douches ; removing the affected tube should symptoms persist. Where, however, the patient clearly has peritonitis of the lower abdomen and it is uncertain whether the primary lesion is in the tube or the appendix, the safer plan is to perform laparotomy and remove infected tubes or appendix, as the case may be. The results of operating on acute cases of inflammation of the Fallopian tubes (salpingitis) are, in our experience, extremely good. In doubtful cases the abdomen should be opened by the paramedial incision below the umbilicus, and if the appendix be normal the tubes explored, packing back intestines with gauze or sponges and placing the patient in the Trendelenb rg position. The distended tube is detached from surrounding adhesions and ligatured at the inner end close to the uterus, while its attachment to the broad ligament is also tied, and the tube can be removed. If possible the ovary is left, but should the latter be infiltrated with pus it also should be removed. Drainage through the lower part of the abdominal incision is often advisable for a few days, but in very severe conditions the most efficient drainage is *via* the pouch of Douglas into the posterior fornix of the vagina : long scissors are inserted up the latter till the points can be felt by the fingers of the other hand (which is inside the abdomen) behind the cervix uteri, when the posterior fornix is divided with a few snips of the scissors, the rectum being protected by the fingers in the abdomen. In less urgent cases, where conservative measures do not cure the condition, the affected tube is removed by a similar operation, but drainage is not often needed in cases where there is no free pus inside the abdomen.

Where the uterus is much involved, as in tuberculous infections, it should be removed as well if the condition of the patient be not too grave. Where there is a collection of pus outside the tubes in Douglas's pouch it is sometimes advised to open the latter through the posterior fornix. This is seldom advisable as a primary operation, since the initial source of trouble, viz. the tube, cannot be removed without great difficulty per vaginam ; hence laparotomy is advisable to commence with, but should a collection of pus arise later, after an operation where the tube has been already removed, drainage through the posterior fornix is an excellent method.

NEW GROWTHS. These are found in the ovary, broad ligament, and uterus. Papillomas, cancers, and fibromas also occur in the Fallopian tubes, but are so uncommon as to be outside the scope of a work on general surgery.

OVARIAN TUMOURS. These may be divided into (*a*) solid and (*b*) cystic.

(*a*) Solid tumours of the ovary are comparatively rare and usually malignant. The most common form is cancer, less often sarcoma, fibroma, myoma, which only require mention. Solid, malignant ovarian tumours (carcinoma) diffuse early to the peritoneum and set up carcinomatosis peritonei, causing adhesions and ascites, the former of which are very apt to give rise to intestinal obstruction. Such conditions are seldom diagnosed till the growth has spread widely and the patient presents herself with a history of increasing size of the abdomen, irregular action of the bowels, dyspepsia, and possibly vomiting. On examination the abdomen is distended with flatus, free fluid may be detected, and a fixed mass can often be felt in the pelvis on abdominal or vaginal examination. In a few instances the growth may be found early while pelvic examination is being made as a rounded tumour connected with the broad ligament. The possibility of such small ovarian tumours being malignant is a great argument in favour of removing all ovarian tumours as soon as they are diagnosed.
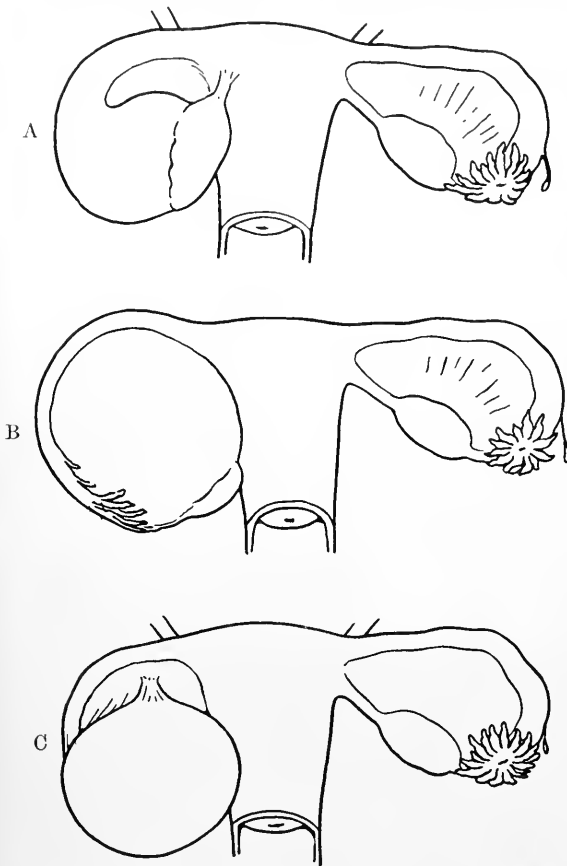
FIG. 104. A, Distension of the Fallopian tube ; hydro- or pyosalpinx. B, Cyst in the broad ligament, parovarian cyst. C, Pedunculated ovarian cyst growing from the ovary proper.

Treatment. When the condition is associated with ascites and intestinal obstruction exploratory laparotomy will usually be indicated, since the diagnosis from such affections as tuberculous peritonitis is often uncertain. Often there is nothing to be done except to close the abdomen, but in a few instances it may be possible to relieve the obstruction by a short-circuiting operation. Thus in one case we found five obstructions in the lower ileum due to secondary deposits from a malignant ovarian tumour, and anastomosis of the ileum above the obstruction to the sigmoid gave satisfactory relief for some months. In the case of small early tumours, removal is performed as for other ovarian cysts.

(b) Cystic tumours of the ovary are of three main types :

(1) The cysto-adenoma (polycystoma) consists of a mass of cysts varying in size from a pea to a pumpkin, lined with columnar epithelium containing fluid or colloid material, which may be straw-coloured, dark brown, or green from the presence of altered blood, which often escapes into the cysts.

(2) Ovarian dermoids (teratomas) are portions of another fœtus included in the patient, and develop as single cysts containing thick, porridge-like material as well as hair, teeth, bones, nipples, and other tissues. These cysts are very apt to become twisted and are mostly found in young subjects, but may give no signs till later in life.

(3) The papilliferous cystadenomas are generally considered to originate in the para-oophoronic tubules, and are masses of cysts inside which are situated papillomatous outgrowths filling most of their interior. The cysts readily burst and the papillomas often form secondary deposits on the peritoneal surface. These tumours are locally malignant, spreading freely in the abdominal cavity, but as a rule not tending to become disseminated to distant parts. The secondaries may continue to grow after removal of the main mass, but sometimes removal of this is followed by cessation of growth in the daughter colonies. These cysts are also found in the broad ligaments, and are less common than the former types of cyst.

Still less common forms are :

(a) Dropsical Graafian follicles, where several follicles become distended with clear fluid, are of little importance, not necessitating removal of the ovary.

(b) Less common but more important are cysts of the corpus luteum, since very severe hæmorrhage may occur from the bursting of these, the result being grave intraperitoneal bleeding closely resembling in its signs the results of rupture of an ectopic gestation. On exploring the abdomen this condition is likely to be mistaken for the even more uncommon condition of primary, ovarian, ectopic pregnancy, but no fœtal tissues will be found in the ovary after removal of the bleeding part, as in the latter condition.

RESULTS OF OVARIAN CYSTS. These tumours may be present a long while unnoticed till the increasing bulk of the abdomen leads to investigation, when the enlargement has to be distinguished from pregnancy, ascites, obesity, gall-bladder tumours, &c.

In other examples local pressure on the bladder or rectum may lead to frequency of micturition or difficulty of defæcation ; pressure on the ureter may lead to hydronephrosis ; pressure on the vena cava will lead to ascites and œdema of the legs, and when very large respiration may be embarrassed.

COMPLICATIONS. (1) *Torsion of the Cyst.* Seeing that the cyst is attached to the broad ligament by a comparatively narrow pedicle, it follows that it may become rotated about this attachment. This complication is most common in dermoids. The exact mechanism causing the rotation is uncertain, it may be movement of the surrounding intestines or of the

abdominal wall. The consequences of such torsion are similar to that in other pedunculated viscera, viz. first venous engorgement, œdema of the cyst, and exudation of serum and fibrin, and finally blood, should the torsion be severe and rapidly produced, so that blood-stained exudate appears in the abdominal cavity. Later the arterial supply may be blocked, causing necrosis of the cyst, or if infection from the neighbouring bowel take place, suppuration or even gangrene may ensue. More often the twisting force ceases to act before gangrene takes place, and the result is that the cyst becomes fixed to surrounding viscera by adhesions and finally these prevent further rotation. Torsion accounts for most examples of inflammation of ovarian cysts.

(2) *Inflammation and Suppuration of Ovarian Cysts.* As just mentioned, these conditions are likely to follow on torsion of the cyst, but may originate independently of this. The source of infection may be the tubes or intestine. A pyosalpinx is fairly often combined with suppuration in and about an ovarian cyst.

(3) *Rupture* of the cyst may result from thinning of the wall, especially where intracystic papillary growths are present, or from sudden violence. The results vary : there may be severe intra-abdominal hæmorrhage with urgent signs ; in other cases the non-irritating fluid is readily absorbed and little effect is produced on the peritoneum ; where the contents are colloid or where papilliferous growths are present there will be a spread of growth to the peritoneum assuming a malignant or quasi-malignant form. The rupture of dermoids or suppurating cysts will set up rapidly spreading peritonitis.

Diagnosis. The clinical aspects vary with the size of the cyst and whether any complications have occurred.

(1) The larger cysts present a dull rounded swelling rising out of the pelvis, possibly mobile but not affected by respiration. There will be resonance in the flanks and a percussion thrill will be noted in the tumour. Usually these cysts are tense but occasionally they are flaccid, and then likely to be missed in fat patients. From a full bladder the catheter will distinguish, while from pregnancy the uterine contractions, fœtal heart-sounds, and changes in breasts and cervix uteri. Uterine fibroids will be harder and often bossy, while on bimanual examination they move with the cervix uteri (it should be noted, however, that a cyst adherent to the uterus will give rise to signs very similar to those of a fibroid tumour). From renal, gall-bladder, omental or mesenteric cysts, the pelvic position of the mass will distinguish, though if the pedicle be long the cyst may be well above the pelvis. The median position of the dullness and the fact that it does not alter with different positions of the patient will distinguish larger cysts from ascites, but fluid loculated in the abdomen may closely resemble an adherent ovarian cyst.

(2) Smaller cysts have to be distinguished from enlargement of the tubes, such as pyosalpinx or tubal gestation ; the presence of vaginitis and a history of pelvic inflammation will suggest the former, while an irregular

menstrual history will be in favour of the latter condition.   The backward bulging of a retroverted uterus should be distinguished on bimanual examination by the forwardly directed os and the absence of the fundus uteri elsewhere, but this condition is often confused with enlargement of the tubes or a small ovarian cyst.   The passage of a uterine sound and correcting the displacement will readily distinguish the condition.   The sound is also useful in distinguishing a large fibroid of the uterus, in which the sound passes over-far, from a uterus to which an ovarian cyst is adherent, since in the latter condition the sound passes the normal distance.

(3) Rupture of a cyst may present the picture of internal bleeding and be indistinguishable from that of an ectopic gestation till laparotomy is performed, though the absence of irregular menstruation, enlargement of the uterus, and uterine bleeding are suggestive points.

(4) Acute torsion may present signs of peritonitis as in other conditions of the " acute abdomen."

(5) More often the twisting is subacute, and the condition is one of peritonitis of the lower abdomen with a history of previous minor but similar attacks.   In fat women the tumour will often be not palpable, and is seldom palpable per vaginam ; in less obese specimens a tumour may be found rising out of the pelvis, over which there is some abdominal rigidity and which is too large for an abscess from an appendicitis to have formed in the time during which the acute affection has been present, while the fever, constipation, slight amount of vomiting, and absence of any evidence of uterine or tubal infection will suggest torsion of an ovarian cyst.

Treatment.   Ovarian cysts should be removed when diagnosed by laparotomy or when found in an exploration for some abdominal crisis.

The abdomen is opened by a paramedial incision below the umbilicus, the patient being in the Trendelenberg position.   Where the tumour is clearly a polycystoma of large bulk it may be reduced in size by tapping with a large ovariotomy trochar, till sufficiently small to come through a four- or five-inch incision.   Where, however, the tumour is solid or on palpation it is suspected that intracystic growths are present, or where the yellow colour shows it to be a dermoid, or where inflammation has taken place, the incision must be enlarged till the tumour can be delivered without tapping.   Removal of the smaller non-adherent cysts is a simple matter ; after delivery the cyst-pedicle is transfixed and tied off with interlocking sutures and the cyst removed.

Large cysts may be very adherent to surrounding omentum and gut, but can generally be separated by patient effort without removing any intestine.   The raw surface left should be covered with peritoneum or omentum to prevent the formation of adhesions, which may later cause intestinal obstruction.   The second ovary should be examined and removed if affected (the patient should be told of the possibility of this being needed before operation).   In all cases the cyst should be packed off from surrounding viscera with sponges or gauze, lest if inflamed it bursts and causes

peritonitis. Drainage is only needed if there be already much free pus in the abdominal cavity.

CYSTS OF THE BROAD LIGAMENT. These are usually single cysts, though two or three may be present together in one broad ligament. They are supposed to be derived from the relics of the parovarium (mesonephros) in the broad ligament. The contents are usually clear fluid : occasionally dermoid cysts are found in this situation, but it is questionable whether these really originated in the ligament or were infolded in the latter as the result of adhesions following inflammation.

Signs. Unless inflammation has taken place the signs are those of pressure in the pelvis, viz. difficulty of defaecation, frequency of micturition, and if large a tumour may be felt in the lower abdomen resembling an ovarian cyst but less mobile. Per vaginam the condition is characteristic, the cervix uteri being displaced laterally away from the cyst so that it may not be readily found, while there is a soft bulging in the lateral fornix. When inflammation and suppuration have occurred the pressure-signs will be exaggerated and signs of peritonitis of the lower abdomen will be noted, including in some cases a swelling in Douglas's pouch.

Diagnosis. In uncomplicated conditions the displacement and fixity of the uterus without inflammation will be fairly conclusive, but where local peritonitis is present the affection may readily be confused with appendicitis or inflamed Fallopian tubes and may be associated with the latter condition.

Treatment. The cyst should be removed by laparotomy in the Trendelenberg position. After packing off the intestine the cyst or cysts are dug out of the broad ligament by blunt dissection and, if not inflamed, the hole remaining in the ligament sutured with deep stitches and the abdomen closed without drainage. Infected cases are drained for two or three days, or if much bleeding occurs the ligament is plugged with gauze for twenty-four hours. If after operation effusion collects in the ligament it may be drained by incision through the lateral fornix of the vagina.

TUMOURS OF THE UTERUS

The only varieties at all common are fibro-myomas or fibroids, and carcinoma, which usually originates in the cervix but sometimes in the body of the uterus.

UTERINE FIBROIDS. These tumours consist of masses of unstriped muscle and fibrous tissue in varying proportions surrounded by a capsule. The growths commence in the later half of sexual life, being very rare under twenty-five and seldom commence after the menopause, while if already present at this period of life they often undergo atrophy. Fibroids are classified from their position :

(a) *Subperitoneal* when close to the peritoneal surface and projecting into the abdominal cavity.

(b) *Submucous* when originating near the interior of the uterus and projecting into its cavity, in which case they form " fibroid polypi."

(c) *Intramural* or *interstitial* when growing in the substance of the uterine wall.

The above terms apply to fibroids growing in the body of the uterus ; less commonly they are found (d) in the cervix.

Fibroids may be quite small and unnoticeable or attain the weight of many pounds. Secondary changes are apt to occur in fibroids when of some size and standing from interference with the blood-supply or infection. The former leads to œdema and softening, " red softening," followed by cystic degeneration and sometimes sloughing ; the latter to suppuration and sloughing—the last result being from a combination of impaired blood-supply with infection.

Signs. In the subperitoneal variety signs may be absent till the tumour is of great size and forms an obvious abdominal tumour. Interstitial and submucous fibroids cause dysmenorrhœa, uterine hæmorrhage, and pressure on the pelvic organs, with frequency or retention of urine, constipation, hydronephrosis, vesical or rectal tenesmus, &c. Uterine bleeding is mostly found with submucous fibroids which tend to be forced out of the uterus as polypi, but also occurs in the interstitial variety. The bleeding is at first with the menstrual periods, and these become of longer duration and the bleeding is more severe (' flooding '), till finally profuse, irregular hæmorrhages or continuous loss of blood takes place. Pain may become a notable feature with the menstrual periods as the uterus tries to extrude the fibroid. This is particularly the case with submucous fibroids, and is a well-recognized cause of dysmenorrhœa coming on in women at about thirty who have previously had normal menstrual periods. Fibroids may also cause obstruction to labour or profuse bleeding when labour is completed.

Diagnosis. The presence of a tumour felt on bimanual examination to be firmly connected with the uterus and to form part of the latter, and the elongation of the uterine cavity as detected with the sound, will usually, in the absence of signs of pregnancy, render diagnosis clear in the subperitoneal or interstitial forms. In the submucous type enlargement of the uterus with dysmenorrhœa and bleeding and no signs of early pregnancy will render dilatation of the cervix with tents, Hegar's dilators, &c., legitimate, and when this has been done the finger will easily recognize the difference between the rounded, smooth mass of a fibroid polypus and the ulcerated chasm of malignant disease.

Treatment. In cases nearing the menopause without symptoms no treatment is necessary. Operative interference is indicated for (a) pressure on surrounding organs (rectum, bladder, ureters, and urethra), (b) profuse bleeding, (c) severe dysmenorrhœa, (d) where the mere size of the tumour is a burden to the patient, (d) where it interferes or will interfere with labour. The type of operation depends on the position of the fibroid.

(1) Submucous fibroids can as a rule be removed from the interior of the uterus after dilating the cervix with tents and other dilators. If the fibroid is polypoid it can be removed by cutting through its pedicle, if more sessile by enucleating from its bed, previously cutting it into smaller pieces

if necessary. Before such operations the vagina is rendered as aseptic as possible with douches of iodine and biniodide of mercury.

(2) Interstitial, subperitoneal, and cervical fibroids are approached by laparotomy. The tumours may be removed from the uterus (myomectomy),
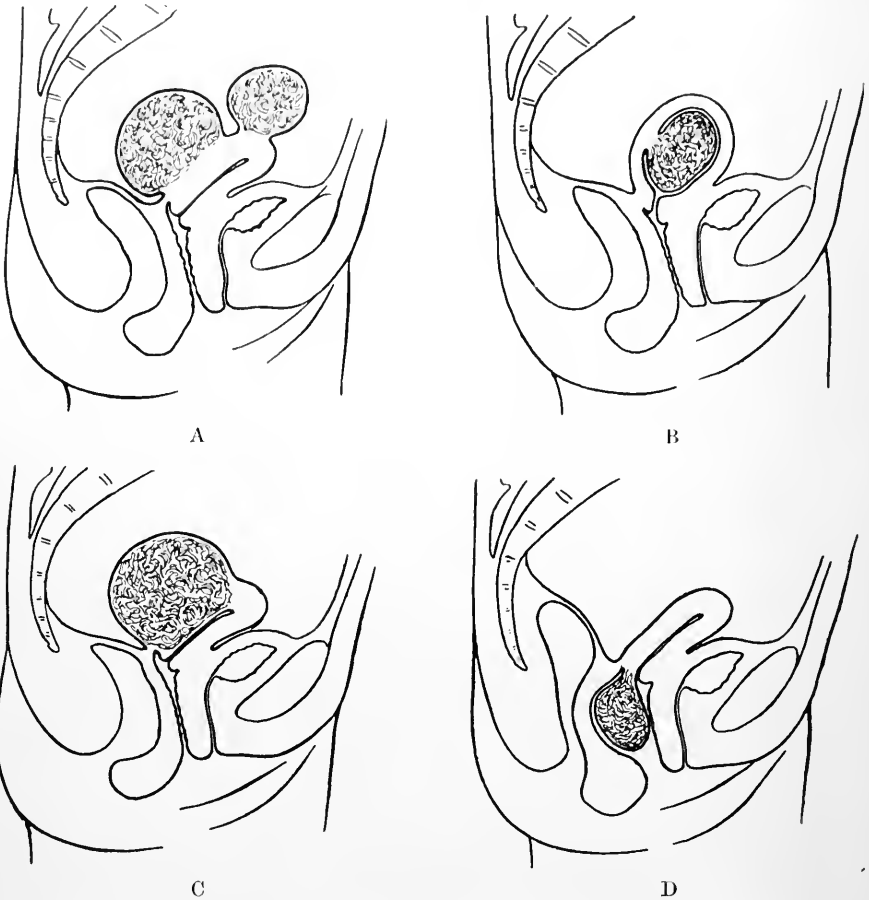
FIG. 105. Position of uterine fibroids. A, Subperitoneal. B, Submucous. C, Intramural. D, Cervical.

which is suitable in the case of subperitoneal fibroids, or the whole uterus may need removal (hysterectomy) as in the case of interstitial fibroids.

(a) Myomectomy is especially indicated in young women, who may still bear children, and where the tumour projects from the wall of the organ or is pedunculated. The pelvic organs are exposed by paramedian laparotomy in the Trendelenberg position and the intestines packed off. The peritoneum is dissected off the periphery of the tumour to allow of covering the resulting raw surface. The tumour is excised or enucleated and the resulting cavity in the uterus closed with deeply inserted, interrupted catgut sutures to check hæmorrhage, and the peritoneal flap raised at the beginning of the operation, then secured over the deeper sutures.

(b) *Removal of the Uterus above the Vagina.* Supravaginal or subtotal hysterectomy is indicated in most cases of fibroids where myomectomy is unsuitable from its difficulty and danger or where the patient is past child-bearing and where the tumours are multiple.

(c) Removal of the complete uterus with the cervix, or *pan-hysterectomy,* is indicated where the tumour is in the cervix. The former, from its more complete asepsis (since the vagina is not opened) is preferable, when possible.

Operation. The uterus is exposed as in the previous operation, the intestines packed off, and the tumour and uterus pulled to the surface with a volsellum. The round ligaments are divided between ligatures, and the broad ligaments are clamped close to the uterus, ligatured further out, and divided between the clamp and the ligature. Before the menopause the ovary is left with the broad ligament, but after this period of life they may as well be removed with the uterus. The branches of the ovarian artery to the uterus are thus caught and tied. Next anterior and posterior flaps of peritoneum are dissected from the lower part of the uterus down-wards and the bladder separated from the anterior surface for about an inch. The uterine arteries are ligatured as they pass inwards in the broad ligament towards the cervix, avoiding the ureters, which pass from behind forwards across the sides of the cervix. The cervix is then cut across, and there should be little or no bleeding if the uterine arteries are properly tied. The anterior and posterior edges of the cervix are brought together with deep interrupted sutures and the peritoneal flaps stitched over all with a continuous suture. Pan-hysterectomy is conducted on similar lines till the uterine arteries are secured. Then the posterior fornix of the vagina is opened under the peritoneal flap and the cervix dissected from the vagina and bladder at the sides and front, carefully avoiding the ureters by keeping close to the uterus ; the apex of the vagina is sutured and the peritoneal flaps closed over this as before.

In either form of operation the main thing is to avoid injuring the ureters, and this is done by keeping close to the cervix. Where pan-hysterectomy is likely to be needed the vagina is rendered aseptic before commencing the operation.

Sarcoma of the uterus may develop in fibroid tumours, but more often arises in young persons. The tumour is similar to that caused by fibroids, but the growth is more rapid and surrounding structures are soon implicated. The treatment is pan-hysterectomy.

CANCER OF THE UTERUS. This is the commonest situation for cancer in women, which originates usually in the cervix of parous women, and is rare under thirty-five years of age. The spread of the cancer is along the broad ligaments to the iliac glands, and may compress the ureters, causing hydro-or pyonephrosis. The ulceration may spread to the bladder or rectum or to the peritoneum, causing carcinomatosis peritonei, and intestinal obstruction. These effects on the intestines and kidneys, together with the debilitating effect of repeated bleeding from the ulcerated surface, will generally kill the patient within a year.

Signs. Irregular uterine bleeding is usually the earliest sign, and, unfortunately, is often attributed to some minor cause and often neglected ; while pain is often only found late when the nerves in the neighbourhood are involved. Irregular bleeding from the vagina in women of over thirty, apart from early pregnancy, is suspicious, and vaginal examination should always be urged in such cases, since uterine cancer is favourable to operative treatment if diagnosed sufficiently early.

Diagnosis. Where the growth is in the cervix, vaginal examination will reveal indurated patches, callous ulcers, or exuberant cauliflower growths, and these readily bleed on examination, which is an important sign, for innocent conditions such as erosions or mucous polypi seldom bleed unless roughly handled. When there is any doubt a portion should be removed and examined microscopically. Where the growth is in the uterine body, vaginal examination will show enlargement of the body of the organ and discharge blood from the os uteri. Dilatation of the os will then be indicated and digital examination of the interior of the uterus, eventually removal of some of the mucosa and microscopical examination. In addition to diagnosis, vaginal examination will afford some clue to the operability of the condition. Where the uterus is freely movable operation should be successful. Where the broad ligaments are infiltrated operation will be feasible but success unlikely. Where the rectum, bladder, or vagina is involved operative interference is best avoided.

Treatment. The operative treatment of cancer of the uterus is an interesting example of the advance in the treatment of malignant disease from a study of its spread. Formerly gynæcologists were content to amputate the diseased cervix through the vagina, cutting through the vaginal mucosa, pulling down the cervix, and cutting off the latter close to the internal os, outside the peritoneum. This is quite inadequate for cure, and often led to dysmenorrhœa from narrowing of the cervical canal in those cases which survived, owing to errors in diagnosis. Vaginal hysterectomy was satisfactory up to a point as shock was slight, the mortality low, and convalescence rapid, but as the removal was very close to the uterus only quite early cases had any prospect of ultimate cure. The small ultimate success of vaginal hysterectomy has caused modern gynæcologists to give up the latter operation in favour of abdominal pan-hysterectomy, with removal of the broad ligaments and clearing the iliac glands (Wertheim's hysterectomy). This method places the treatment of cancer of the uterus on the same footing as that for cancer of the breast, stomach, intestine, &c., since the whole area of probable spread of cancer both in lymphatic and cellular tissues is removed *en bloc.*

Operation. The vagina is cleansed and the growth, if cervical, cauterized to avoid contamination in the later stages of the operation. The abdomen is opened as in the previous operations and the uterus pulled up. The ureters are exposed in the outer posterior part of the broad ligaments and the ligaments detached from their outer attachments to the pelvic wall, tracing the ureters forward to the bladder.

The uterine and ovarian arteries are tied close to the pelvic wall and the uterus, after dividing the peritoneum, separated from the bladder and rectum.   The dissection is carried down along the upper third of the vagina. The latter is then divided between the two clamps, the affected cervix being thus secured inside the part of the vagina which is removed.   The dissection is carried along the internal iliac vessels and the glands in this situation removed with the broad ligament.   The vagina is then closed with sutures and the peritoneum in turn sutured over the raw surface.   The operation is prolonged and severe, but at present the mortality is not high and the ultimate results are far better than those following vaginal hysterectomy.

SECTION VI

THE ORONASOPHARYNX AND ITS CONNEXIONS

THE two main apertures of the face, the nose and mouth, present in their anatomy, physiology, and development so many points of connexion that they may be regarded as one region ; for convenience of description to these may be added the face and orbit and the connexions of the main respiratory and alimentary tubes in the neck, such as the salivary and thyroid glands. The ear also presents important relations with the naso-pharyngeal portions of this region, but surgically is connected to the central nervous system by such important relations that it has been included in that section.

CHAPTER XXV

CONGENITAL DEFECTS OF THE ORONASOPHARYNX, CLEFT-PALATE, HARELIP, BRANCHIAL DEFORMITIES, ETC.

Development of the Oral and Nasal Cavities : Macrostoma : Microstoma : Mandibular Cleft : Median Harelip : Oblique Facial Cleft : Macrocheilia : Cleft-Palate and Lateral Harelip : Treatment of Cleft-Palate and Harelip : Branchial Fistula : Branchial Cysts : Thyroglossal Cysts : Skin-Dermoids.

A BRIEF account of the development of these cavities will facilitate the understanding of deformities which may occur.

During the earlier stages of fœtal life the primitive gut ends blindly in front as it does behind.   In the first month of fœtal life a depression forms in the front of the ventral surface of the embryo between the fore-brain and the cardiac region, and passes back to join the front of the fore-gut. This depression is the *stomodæum*, and is the origin of the nasal and buccal cavities.   The primitive oropharynx, formed in this manner, is gradually differentiated by outgrowths and depressions of its walls till the nasal, buccal, pharyngeal cavities and the thyroid, lungs, trachea, pituitary body, &c., are formed.   The stomodæum is gradually covered in by outgrowths, viz. in front the mesial and lateral nasal processes, at the sides the maxillary, and behind the mandibular processes.   Between the lateral and mesial nasal process are the olfactory pits or rudiments of the olfactory mucosa. Between the lateral nasal process and the maxillary process is the rudiment

of the eye. The mesial nasal process grows down into the primitive buccal cavity to form the nasal septum, the philtrum of the lip, and the central part of the præmaxilla, bearing one tooth on either side. The lateral nasal process forms the alæ nasi and adjoining part of the cheek. The maxillary process forms the rest of the cheek, the alveolar margin of the upper jaw and the teeth, and from it a prominence grows inwards to meet its fellow of the opposite side and the nasal septum ; this process forms the bulk of the hard and soft palates.

Various deformities arise from failure of these processes to unite, viz. :

(1) Failure of the bifid extremity mesial nasal process to unite results in " median harelip," a very rare condition.

(2) Failure of the mesial nasal process on the one side to unite with the lateral nasal and maxillary process on the other results in ordinary lateral harelip and cleft-palate, which may be combined or occur separately, according as the defect in union is complete or partial.

(3) Failure of the lateral nasal and maxillary processes to unite (the normal fusion of which is incomplete, leaving the nasal duct) may be still more incomplete, leading to the rare deformity of " oblique facial cleft."

In the floor of the primitive oral cavity are developed the visceral arches and clefts (branchial or gill clefts). The first arch becomes the maxilla, the second the body of the hyoid, the third the lateral part of the hyoid, while the third and fourth form the thyroid and cricoid.

The first visceral cleft forms the Eustachian tube, tympanic cavity, and external ear. The second persists normally as a depression behind the opening of the Eustachian tube in the lateral wall of the nasopharynx, known as the fossa of Rosenmuller, or may remain patent throughout its length as a " branchial fistula " or closed at the ends and open in the middle as a " branchial cyst." From the floor of the mouth the tongue is developed as three projections, one anterior and two symmetrical posterior projections; the junction of the
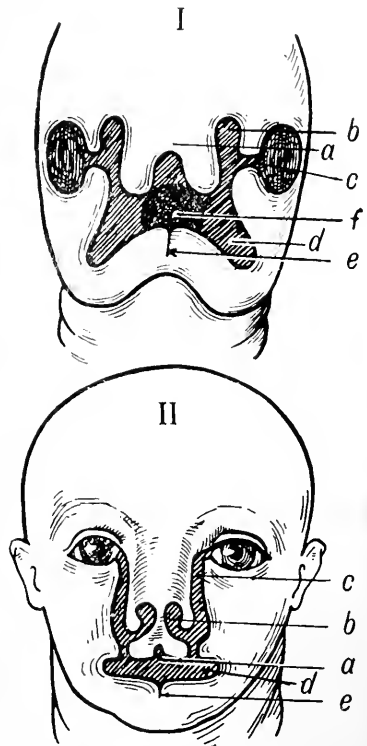
FIG. 106. Development of the mouth and nose, and the deformities resulting from failure of various parts to unite. a, Mesial nasal process, which is bifid, and if the parts fail to unite results in median harelip. b, Olfactory pit, between the mesial and lateral nasal processes (represented in the lower figure by the nostril). c, Cleft between the maxillary process and the lateral and mesial nasal processes. This persists as the nasal duct, and if insufficiently closed results in an oblique facial cleft. Failure of the lower part of the maxillary process to unite with the mesial nasal process results in lateral harelip and cleft-palate. d, Cleft between the maxillary and mandibular processes, or mouth. e, Cleft between the halves of the mandibular process (mandibular cleft). f, Stomodæum.

former with the latter being marked by the circumvallate, papillæ and the foramen cæcum.

The latter represents the place where the outgrowth which forms the thyroid gland originates. The upper part of this protrusion normally becomes obliterated after joining protrusions from the third and fourth visceral clefts which form the lateral lobes of the thyroid gland. Persistence of the first-mentioned part of the
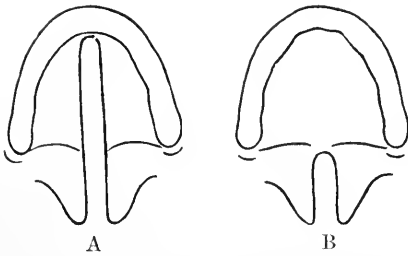
Fig. 107. A, Cleft of soft and all hard palate except the præmaxilla. B, Cleft of soft palate only.
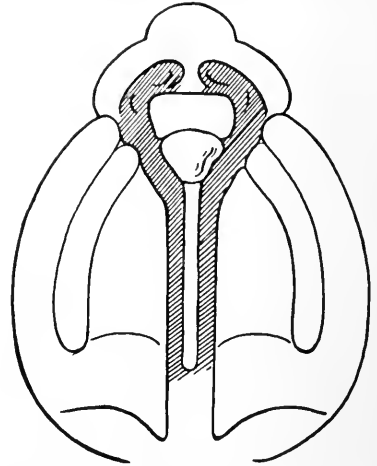
Fig. 108. Complete cleft-palate and double harelip; the nasal septum does not reach either side of the palate in this example.

thyroid diverticulum leads to the formation of thyroglossal cysts and fistulæ or lingual thyroid tumours in the posterior part of the tongue.
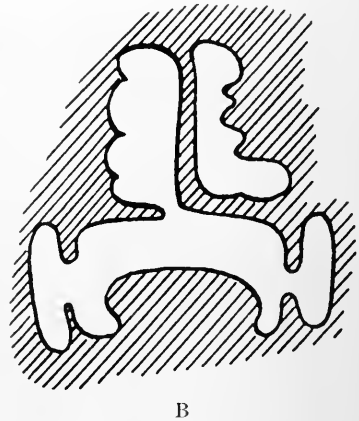
Fig. 109. Varieties of cleft-palate (in vertical section). A, Nasal septum does not reach the palate. B, Nasal septum united to the palate on one side.

MACROSTOMA. In this condition the aperture of the mouth is over-wide from imperfect union of the maxillary and mandibular processes.

MICROSTOMA. Microstoma is the converse condition to the above, due to excessive union of those processes. Besides the congenital type, microstoma may be due to the results of severe ulceration and cicatrization of the lips and cheeks.

Treatment consists in plastic operations to restore the mouth to its proper dimensions.

MANDIBULAR CLEFT. This results from imperfect union of the two mandibular processes in the middle line; the cleft may involve the soft parts only or extend to the bones as well. Here again plastic operations are a cosmetic and nutritional necessity.

MEDIAN HARELIP. This is due to a failure of the mesial nasal processes to unite in the middle line, and is distinguished from ordinary harelip by the defect being exactly in the middle line and not on one side.

OBLIQUE FACIAL CLEFT. This deformity results from non-union of the maxillary and nasal processes, so that there is a cleft from the inner end of the eyelids to the outer angle of the mouth, the nasal duct being thus imperfectly closed in.

MACROCHEILIA. This is a thickened condition of the lips due to over-growth of lymphatic spaces, or, in other words, a diffuse form of lymph-nævus.

Median harelip and the oblique cleft may be closed by plastic operation, and macrocheilia will be improved by cutting away a wedge of redundant lip.

CLEFT-PALATE AND HARELIP (LATERAL HARELIP)

These are by far the most common defects in this region, often occurring in combination,

FIG. 110. Double harelip with but little protrusion of the prolabium.

and, according as the harelip is single or double and the palate partly or completely cleft, various types of deformity arise.

As has already been mentioned, lateral harelip is due to a failure of the mesial nasal and the maxillary process to unite in their more superficial aspects. Where this occurs on one side only the jaw is often unaffected, but where the harelip is double there is usually a failure of the mesial and lateral nasal processes to unite in their deeper portions, the result being that the philtrum and os incisivum (developed from the mesial nasal process) project forward out of the normal line of the alveolar margin and the cleft extends into the nostril. When the palatine processes of the maxilla fail to unite, the cleft may be partial, involving only the uvula (bifid uvula) or the soft palate in addition, or may extend the whole length of hard and soft palates. If the latter condition be present with the more complete type of harelip the cleft is complete from lip to uvula, running up into the nostril.

When incomplete, the cleft in the palate is always in the posterior portion,

but such partial cleft of the palate may co-exist with a very complete degree of harelip. The relation of the cleft in the palate to the nasal septum varies ; in some instances the palatine process reaches the septum on one side, but in others the septum is separate from both sides of the hard palate and is small and ill-developed. The cleft in the palate varies much in width ; as a rule partial clefts are narrower than those more complete. The arch of the palate-vault also varies considerably ; it may be wide and low (Norman) or narrow and acutely arched (Gothic), the latter style being more conducive to successful operations. In addition to being too narrow the palatine processes are often too short from before backwards, so that the soft palate does not extend back to reach the back of the pharynx, and this is one of the reasons of failure to attain good functional results in otherwise successful operations, for the aperture which remains between the mouth and nasal cavities renders vocal resonance abnormal as well as rendering the patient liable to regurgitate liquids through the nose ; the latter effect is, however, seldom of much trouble, as the patient learns to swallow even with a cleft-palate.

Fig. 111.   Double harelip with much protrusion of the præmaxilla (prolabium).

As regards diagnosis, the condition is usually evident in the major conditions, but all new-born infants should be examined with regard to the palate or the minor degrees may escape observation.

Treatment. The indications vary somewhat according as the lip and palate are affected separately or together.

(1) Where the lip alone is affected and the defect is not great, so that the infant is unlikely to suffer from malnutrition, or where, although the deformity is severe, the surrounding conditions are good so that spoon-feeding can be properly carried out (especially if the surgeon be not in much practice with these operations), it will be well to defer operation till the infant is three months old, but it should certainly be done before dentition commences. Where the defect is gross and the surroundings bad, so that malnutrition is likely to result, and the surgeon is practised in this class of work, the operation should be undertaken as soon as possible after birth, as it may be possible to establish breast-feeding, which is the best thing for the infant. Thus early operation is especially indicated for hospital patients.

(2) Where the condition is one of cleft-palate, whether the lip is involved or not, the question becomes more complicated. We have to consider the

possibility of increasing the infant's chances of living by operation, with view of improving its powers of swallowing ; the improvement of speech must also be considered, though this is secondary to the former desideratum.

In the first place, there can be little doubt that the mortality amongst infants with severe deformities of the palate is very high during the earlier months of life, if left untreated. The difficulty of feeding and the repulsion felt by the parents for these unfortunates renders their lives extremely precarious, especially in the poorer classes. Early operation for such cases, as advocated by Lane, seems perfectly rational, since the frequent occurrence of severe deformities in small infants and their comparative rarity in older children makes it tolerably certain that numbers perish during the first few weeks of life. In such cases operation should be done as soon after birth as possible (the difficulty is to get the patients early enough, as they rapidly waste and may be in a bad condition within three weeks). Operation in such patients is rather to be regarded as a means of saving life than of improving speech. The latter result is unlikely to be brilliant except in cases where the cleft is narrow and the operation correspondingly easy. Another reason why operative measures are often unsatisfactory as

Fig. 111a. The same case, showing the large cleft-palate.

regards speech is that many of these patients are mentally defective, and in some instances to a marked degree.

Where the cleft is narrow so that repair by a sliding-flap operation (*see later*) is likely to be successful, and the patient is in good circumstances so that its nutrition is fairly well assured, operation on the palate may reasonably be deferred till after the first year, and in such cases speech may be quite good. Such delay is advisable where the experience of the surgeon is not great. Most patients of the poorer classes or where the cleft is very large are best operated on during the first few weeks of life. Quite young infants stand these operations well, are less restless and less likely to suck the wound than older children, while the edentulous mouth of small infants is less liable to sepsis. Where operation is deferred till patients are two years old or more the technique will always be easier owing to the larger size of the parts, and also because the worst cases will not survive.

Treatment of Harelip. The lip at the close of operation should be deeper than normal from nostril to lip, since the site of the operation-scar will contract longitudinally, and if the lip is of the right depth at the time

of operation there will be a partial recurrence of the deformity within a
few months.

Operation. The infant should be on its back with the arms fastened
to the sides and the head well extended, so that if much bleeding takes place
it will gravitate into the nasopharynx and not into the trachea. The
anæsthetic should be chloroform and ether on an open mask continued
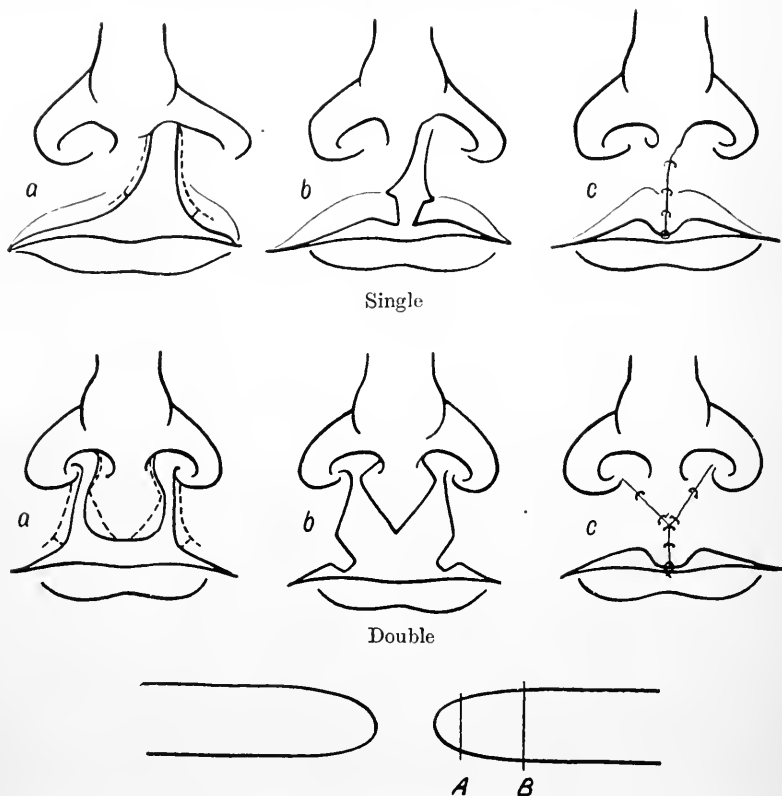
Fig. 112.   Operations for harelip.   Paring the edge.   A, Insufficient.   B, A good
wide paring removed.

from a Junker's inhaler if need be, but in the more ordinary cases the
operation takes so short a time that with moderate depth of anæsthesia it
will be finished before the patient comes round. The lips and the alæ nasi
(which are always displaced outwards on the affected side), after painting
with iodine solution, should be dissected up with scissors from the maxilla
till the above defect can be fully rectified. The edges of the cleft are then
pared from above down with a sharp knife, taking care that the paring is
of the whole thickness of the lip and not merely of the edge. The paring
process is continued towards the mouth, deviating further from the cleft
at its lower end. The upper two-thirds of the parings are then cut away on
either side and the pared edges sutured with fine silkworm-gut, passing
through the whole thickness of the lip, securing good apposition and avoiding

inversion ; the lower part of the paring is turned down on either side and sutured so that there is a projection from the lower border of the lip, which contracts considerably in the next few months and if too prominent after a year may be trimmed down again.   For double harelip the operation is similar, but both sides of the portion of lip on the os incisivum are pared as well as the two edges of the main cleft in the lip.

Treatment of the Os Incisivum.   Where this is unduly prominent it will cause tension on the suture-line and render the latter likely to give way, besides causing deformity, if left *in situ.* This bone should never be removed ; it may sometimes be bent forcibly back, cracking at its attachment to the nasal septum, and if this fail the attachment to the nasal septum should be divided with a small chisel after continuing the stripping of the central part of the lip (philtrum) up till this point is reached.   At the same time mucous membrane should be removed from the side of the os and the corresponding side of the maxilla, so that firm union will take place. Although immediately after this manœuvre the nose is depressed at its lower end and the face appears monkey-like, the deformity soon subsides, the nose assuming its correct shape, and the os incisivum blocks the gap in the anterior part of the palate.

As regards after-treatment, dressings should be avoided, as if well sutured there is no risk of the wound giving way, and dressings only collect nasal discharge and make for sepsis ; moreover the scab which forms in a few hours effectively seals the wound against the entrance of organisms. Where the nasal passages are not freely open the condition of respiration should be noted immediately after operation, as in some instances there is real danger of suffocation from closure of the mouth and the latter will need propping open till the patient is accustomed to the new channel of respiration.

OPERATIONS FOR CLEFT-PALATE.   There are two main plans for obviating the defect, both by means of plastic flaps, which may be (1) sliding flaps (Langenbeck) or (2) turnover flaps (Colley, Lane).

Mention must also be made of Brophy's method, which consists in bending or fracturing the attachments of the upper jaws and pushing them inwards so as to narrow the cleft. Since, however, the defect is not that the upper jaws are too far apart (in adults with cleft-palate the teeth of the upper jaw are in alignment with those of the lower) but that the palate is too narrow and short, this plan seems wrong in principle and is unsatisfactory in practice, giving but little approximation of the edges.

The method by sliding-flaps consists in raising the mucoperiosteum from the hard palate and detaching the soft palate from the hard in continuity with this, paring the edges of the cleft and suturing these together, tension being relieved by lengthening the incisions at the outer border of the hard palate (through which it has been elevated) and dividing through these same incisions the insertions of the tensor and levator palati into the soft palate.   The method by turnover flap consists in raising on one side a flap

of the mucoperiosteum of the hard palate and half the thickness of the
soft palate, its free edge being at the alveolar margin and lateral attachment
of the soft palate, its base being toward the middle line, *i.e.* at the cleft.
This flap is turned completely over so that its raw surface faces the mouth,
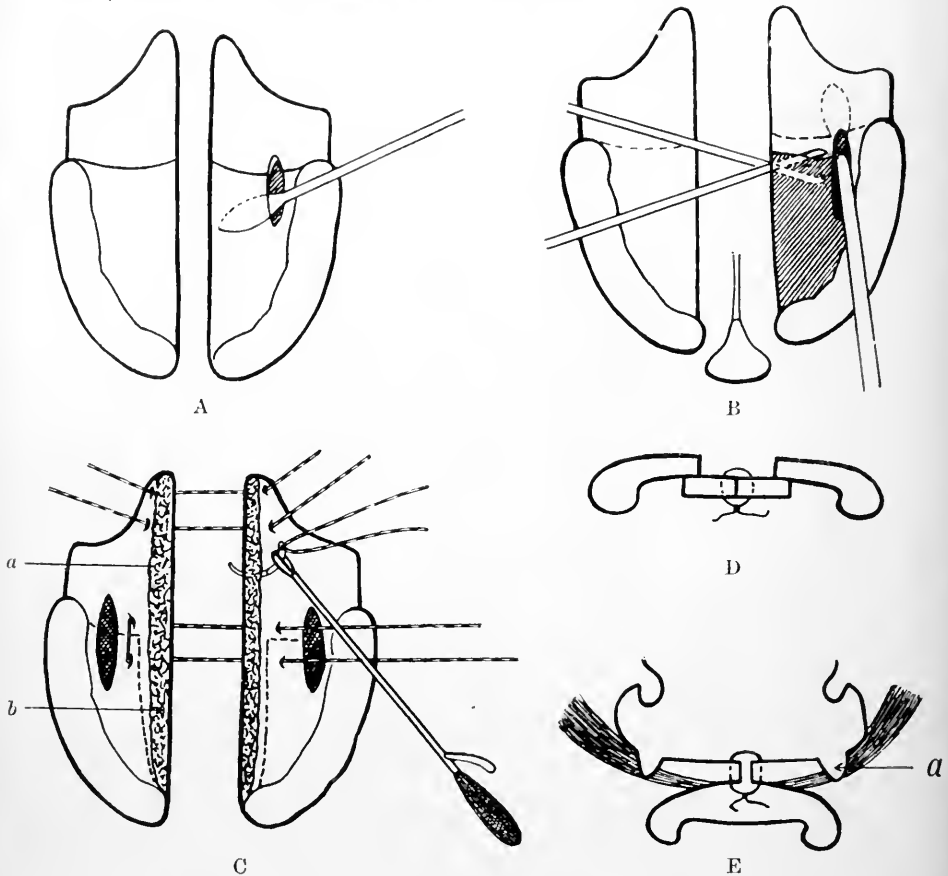
FIG. 113. Standing flap operation for cleft-palate.   A, Dissecting the mucoperi-
osteum from the hard palate.   B, Freeing the junction of the soft with the long
hard palate.   C, Suturing the edges of the cleft after paring the latter.   *a*, Soft
palate ; *b*, mucoperiosteum of hard palate.   A mattress-suture is inserted to secure
good co-aptation of raw surfaces.   D, Section showing how mucoperiosteal flaps
fit.   E, Section showing suturing of soft palate.   The cut (*a*) divides the tensor
and levator palati and so relieves the tension.

its mucous surface the nasal cavity, and its free edge is placed under a flap
raised in a similar manner to that employed in the sliding-flap operation.
It is usually clear whether the gap can readily be filled by the sliding-flap
method before commencing, but where there is any doubt we dissect up a
flap on one side as for making a sliding-flap and see how far it will come
across.

If this flap can readily be brought across the middle line without tension
a similar flap is made on the other side and the operation finished by Langen-
beck's method, but where the gap is wide and there will be tension we finish

by Lane's method. Owing to the wider surfaces brought into apposition by the turnover-flap method, it is more often suitable for operations on small infants.

Operation. The patient is in the dorsal position with the head well extended (in the case of infants it is convenient to place the patient on a small trough elevated about three inches from the table with the extended head resting on the latter) ; anæsthesia is induced with chloroform and ether and continued with Junker's inhaler. A catheter is inserted through one nostril into the most dependent part of the nasopharynx, and a suitable pumping arrangement attached to this will empty the nasopharynx of blood and mucus as it fills, thus reducing the necessary swabbing to a minimum. The tongue is secured with a suture so that it can be drawn forward as required and the mouth kept open with a gag, of which Lane's type is most convenient for infants, the small spikes assuring a good hold in the gums. The surgeon stands above the head with the assistant and anæsthetist on either side. Some prefer to operate with the patient on one side and the mouth downwards so that blood runs out, but such feats are unnecessary and infinitely tedious. The mucoperiosteum is incised close to the alveolar margin and parallel to this for about half the length of the hard palate and a short distance of the soft. Through this incision the mucoperiosteum is raised from the hard palate with a rugine till the instrument protrudes in the cleft all along the hard palate, and the junction of the hard and soft palates is reached by separating backwards. The soft palate is then entirely separated from its attachment to the bone of the palatine process, so that the flap consists of the mucoperiosteum of the hard palate and the whole thickness of the soft palate. The separation of the attachment of the soft palate is done partly through the lateral incision, partly by pulling the soft palate forwards and inserting scissors (sharply curved on the flat) through the space between the mucoperiosteum and bone at the edge of the cleft, and thus cutting the attachment. The flap thus formed is examined as regards its size and adaptability : if it comes easily across the middle line the same procedure is practised on the other side, but if there is difficulty a knife is inserted through the lateral incision and the dorsum of the soft palate incised till the tensor and levator palati are divided ; this may render the flap sufficiently free. If it be decided to proceed with the sliding-flap method, a flap is raised on the second side in an exactly similar manner and the edges of the cleft in the soft palate pared freely so as to form a wide raw surface (the edges of the cleft in the hard palate are already raw). The pared edges are brought accurately together with fine sutures of silkworm-gut introduced with small curved needles and a long fine needle-holder (in small infants the very small but rather stout needles and holder introduced by Lane are excellent). The plan of introducing loops of silk and using these to pull through the final sutures is tedious and archaic. Special care is needed that no inversion of the edges takes place, for as the raw surfaces are not very extensive, accuracy of apposition is essential. The part most likely to give way is the junction

of the hard and soft palates, and it is a good plan here to secure a wider contact of raw surfaces by the use of a mattress-suture (Fig. 113, C).

If there is any tension the lateral incisions must be enlarged till the sutured palate hangs freely.

Where it is decided that a turnover flap is needed it is necessary to raw the upper surface of the soft palate of the side first attacked (the upper
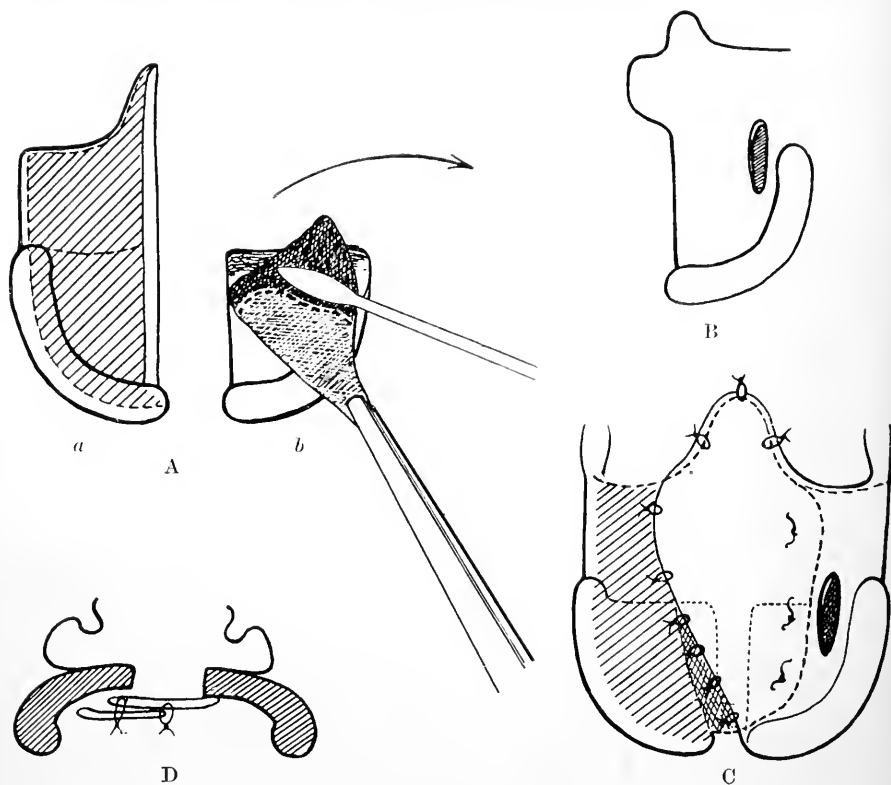
FIG. 114. A, Turnover flap operation for cleft-palate. *a*, The turnover flap of hard and soft palate. *b*, Cutting the reverse turnover flap of the nasal surface of the soft palate. B, Flap of soft palate turned. C, Turnover flap sutured to deep (upper) surface of the reverse flap. D, Section of the turnover flap operation.

surface of the mucoperiosteal covering of the hard palate is, of course, already raw). This is done by catching the uvula with toothed forceps and pulling the soft palate forwards so that the upper surface turns to the operator, and a flap is cut from its upper (nasal) surface with the base towards the middle line, consisting of half the thickness of the soft palate. Where the nasal septum is attached to the hard palate on one side, this is the side to attack first, and a considerable portion of the mucoperiosteum of the septum may be raised with that of the hard palate, thus securing a wider flap. The next step is to make the turnover flap from the untouched side by incising along outside the alveolar margin and raising the muco-periosteum towards the middle line by blunt dissection. When the soft

palate is reached the flap is continued of equal extent, cutting through the attachment of the latter to the wall of the mouth and splitting it in half (the soft palate is a good deal thicker than might be imagined and can be readily split, as shown in the diagrams); when the splitting process approaches the middle line the flap can be turned over easily, and care is needed not to go too far or the flap may be torn from its attachment. The second flap is then secured under the first with three or four mattress-sutures and the edge of the first flap tacked down with six to eight sutures to its under-surface, thus reducing the raw surface considerably.

The operation may finish with closure of the harelip if this be present, and adjustment of the os incisivum, but in general it is better to defer these final touches for a second operation, as closing a large cleft is about enough.

After-treatment. As far as possible interference should be slight ; food should be sterile and, of course, liquid. Milk, though apt to form curds which stick about the sutures, is as good in practice as other more completely liquid diets. Small doses of opium are indicated if the infant is very restless. The mouth may be kept clean by painting with dilute iodine solution once daily, but if infection of any severity takes place the suture-line will almost certainly break down in spite of local measures of asepsis. It is therefore most important to cure any infective condition about the nose, mouth, ears, &c., before operation is undertaken. The stitches should be removed on the tenth day, an anæsthesia being administered if necessary.

Results. Where a sliding-flap operation is successful at the first attempt it will probably give a better functional result as regards speech than one by the turn-over method. But where wide clefts are present speech is not likely to be good by either method. The amount of raw surfaces brought together in the turn-over method renders success at the first operation more probable than by the other method, and the amount of raw surface left uncovered is not very great, so that the resulting deformity by scarring in the soft palate is not as much as might be expected, and the soft palate is the place where scarring is most likely to be detrimental. Excessive fibrosis in the hard palate is of no significance. Hence the turn-over method is useful where the sliding flap has failed in the hard palate, as for filling in gaps of this region the turn-over plan is excellent.

Later After-treatment. This is of prime importance if speech is to become anything like normal, for, however successful the operation may be surgically, there will almost certainly be a deficiency in length of the palate in the more severe cases, so that the nasopharynx is imperfectly cut off from the mouth at the back. The result of this is that all explosive consonants— p, b, d, t, g, f, &c.—tend to be improperly pronounced. It should be explained to the patient—or rather, the parents—that operation forms only part of the treatment as far as speech is concerned, and the child, when able to talk, should be practised carefully over those consonants the pronunciation of which is imperfect. The teacher pronounces each letter slowly in front of the patient so that the movements of respiration of the lips, tongue, and palate can be followed by the latter, and where the patient

can afford to be trained by those who treat stammering and other defects of speech the result will well repay the time and trouble.

Where the deformity is allowed to persist till adolescence or adult life, unless of minor degree or affecting the lip only, operation is not worth the pain and discomfort, and an obturator fitted to a tooth-plate or retained by suction may be used, though most patients will prefer to get on without such mechanical devices.

MALFORMATIONS OF THE BRANCHIAL CLEFTS. The first gill-cleft, as has been mentioned, forms the Eustachian tube, tympanum, and external ear. Various malformations may occur, such as atresia of the external auditory meatus (see Surgery of the Ear, vol. i, p. 606), or little tags of skin, some of which contain cartilage, may be found in front of the ear and below this, on the side of the neck. These " accessory auricles " may be snipped off if unsightly.

The remaining branchial clefts normally disappear, but may persist partly or wholly. When the whole cleft persists the result is a branchial fistula ; when the middle part alone remains patent a cyst is formed.

BRANCHIAL FISTULA. This is present at birth, but may not be noted for some time after, as a small fistulous opening at the inner edge of the lower end of the sternomastoid muscle. The fistula passes up in the neck along the carotid arteries, lying between the external and internal, to end at the pharynx in the fossa of Rosenmuller, just behind the Eustachian tube. The upper part of the tract may be missing. The deeper part is lined with columnar, the more superficial part with squamous epithelium. The fistula may persist indefinitely, discharging a small amount of mucus, but generally inflammation occurs about its external orifice and with formation of abscesses, which are apt to recur as long as the fistula remains.

Treatment. It is possible to dissect out the fistulous tract entire, but this involves a very large dissection of the deeper structures of the neck. A neater plan is to dissect out the lower part of the fistula and free it from the skin, then pass a fine bougie up the fistula till it emerges in the pharynx, where it is secured. A ligature tied tightly round the bougie and dissected end of the fistula secures the latter to the former, and then, on pulling the end of the bougie which protrudes from the pharynx, the fistula is turned inside out and can be tied off and cut away from the pharyngeal termination. Where the upper part of the fistula is impervious and this manœuvre cannot be carried out, we have found that twisting the lower part of the fistula will enable the greater part of the tract to be removed without much dissection.

BRANCHIAL CYSTS. These are formed of unobliterated portions of the second cleft and are found in adolescents (usually females) beneath the sternomastoid, close to the angle of the jaw. The growth is painless, and often attains some size before advice is sought. The condition most likely to be confused with this is a breaking-down tuberculous gland or cold abscess in the same situation (which is also a far more common condition) ; the absence of inflammation, pain, or other enlarged glands will render the

fluctuating tumour suspect, but diagnosis can seldom be made before operation.

Treatment. The cyst should be dissected out. The contents will be found as a rule to consist of yellow pultaceous material as in other skin-dermoids. Some of these cysts are said to contain glairy fluid and to be lined with columnar epithelium, *i.e.* they owe their origin to the deeper or pharyngeal part of the branchial cleft.

DEFORMITIES OF THE THYROID DIVERTICULUM. (1) Thyroid tissue may develop about the foramen cæcum, giving rise to a *lingual thyroid* (*see* Affections of the Tongue, p. 426).

(2) The lower part of the diverticulum, instead of disappearing, may persist and become distended with fluid, forming a cyst, or burst on the surface, forming a fistula (*thyroglossal cyst* and *fistula*). Inflammation and abscess-formation frequently occur about either of these formations. These cysts are usually below the hyoid, in front of the thyroid cartilage, and less superficial than dermoid cysts derived from the skin. Thyroglossal fistulæ pass upwards either deep to the hyoid bone or very often through its substance.

Treatment. The cyst or fistula is dissected out ; in the latter instance this may be an extensive proceeding, as the hyoid bone will often need division before the whole track, which is lined with epithelium, can be completely dissected out, and unless this be done recurrence is almost certain.

SKIN-DERMOIDS. These are found in the middle line of the front of the neck, at the outer angle of the orbit, and at the junction of the bony with the cartilaginous part of the nose, from abnormal closure of the integuments in the middle line of the body. The occurrence of cystic swellings in these situations in infants and young persons close under the skin but not adherent to it will suggest the diagnosis, and excision is usually simple. The nasal type is more commonly represented by a pit filled with an abnormal growth of hair, a sort of nasal whisker.

SURGERY OF THE ORBIT, FACE AND LIPS

Injuries of the Orbit : Inflammations of the Orbit : Tumours of the Orbit :
Excision of the Eye : Exenteration of the Orbit : Surgery of the Face :
Inflammations of the Lips : New Growths of the Lips.

INJURIES OF THE ORBIT. (1) *Hæmorrhages and Ecchymoses into the Orbit.* It is important to distinguish a " black eye " due to local bruising from that following on fracture of the anterior fossa of the skull. In the former instance the bruising appears within a few minutes and involves the palpebral more than the ocular conjunctiva, while the latter condition seldom is noted for twelve to twenty-four hours after injury and forms a triangular patch on the ocular conjunctiva. Profuse bleeding in the latter instance may cause protrusion of the eyeball (exophthalmos or proptosis).

(2) *Punctured Wounds of the Orbit.* These are due to the impact of pointed objects, bullets, &c., and if passing upwards readily fracture the orbital plate of the frontal bone and may injure the optic nerve or ocular muscles. The resulting hæmorrhage and inflammation may lead to fixity of the eyeball or exophthalmos. Such wounds need careful investigation and treatment, enlarging the wound if need be. X-rays may afford valuable information as to the presence of foreign bodies, and the wound is explored with due respect to the eyeball, its nerves and muscles. Foreign bodies are removed with care, especially where the base of the skull is perforated, and drainage established for a few days. Fractures of the bony wall of the orbit are of little consequence in themselves, but as the base of the skull may be fractured or the globe of the eye or its nerves injured, these complications must be borne in mind.

INJURIES OF THE EYEBALL. These include rupture of the iris ; dislocation of the lens ; punctured wounds of the cornea, sclerotic and dangerous area (circumcorneal zone) ; bursting of the sclerotic ; and are described in works on ophthalmology. Certain of the more severe injuries or their sequelæ, such as ophthalmitis, demand excision of the globe, as described later.

INFLAMMATIONS OF THE ORBIT. *Orbital cellulitis* and *orbital abscess* usually follow penetrating wounds, but may result from pyogenic disease of the surroundings, such as osteomyelitis of the maxilla and malar bone, suppuration in the maxillary or frontal sinuses, &c., or be due to pyogenic infection from distant parts.

Signs. High fever, rigors, exophthalmos, fixity of the globe, and impaired vision from haziness of the cornea and pressure on the optic nerve.

Should the infection spread back, the cavernous sinus may be involved and thrombose, with fatal result.

Treatment. The cellular tissue should be widely opened at the point where swelling is greatest, which is usually below the lower lid, and free drainage established. Where the eyeball is destroyed or hopelessly damaged it should be removed.

TUMOURS OF THE ORBIT. These may originate in the globe of the eye or invade the walls from surrounding structures, such as the jaw or frontal bone. It is customary to include amongst tumours formations other than new growths, such as mucocœles of the ethmoidal cells, which form a swelling on the inner side of the orbit above the tendon oculi, orbital aneurysms, &c.

The signs of an orbital tumour are exophthalmos or protrusion of the globe, which is seldom directly forward but away from the growth, *e.g.* upwards where the tumour starts in the jaw, downwards where the latter originates in the frontal bone. The eyeball becomes fixed from pressure-paralysis of the muscles and vision fails from pressure on the optic nerve, optic neuritis or atrophy being noted with the ophthalmoscope. The conjunctiva becomes congested and the cornea hazy and possibly ulcerated from impaired venous and lymphatic return, and because, owing to the exophthalmos, the lids do not properly cover the globe.

Tumours starting in the globe are glioma of the retina and melanotic cancer of the choroid. The former condition is found in small infants and children. Vision fails and the pupil is seen to have a grey reflex, and with the ophthalmoscope the tumour may be seen bulging the retina ; the ocular tension increases, finally the globe bursts and the tumour disseminates into the orbit. Melanotic cancer starts in the choroid and causes detachment of the retina and failure of vision. Dissemination is. variable, and may be delayed for many years after the eye is removed.

Tumours of the frontal bone may be ivory exostoses or collections of pus or mucus in the frontal sinus ; of the upper jaw, sarcomas, epitheliomas, or distension of the antrum of Highmore ; from the integuments rodent ulcers and epitheliomas also invade the orbit.

Treatment. If possible the tumour should be removed or otherwise cured (*e.g.* mucocœles or empyemas of the antrum) before the globe is much damaged. Where the tumour is part of a large invading tumour, *e.g.* of the jaw, or a large rodent ulcer, it may be necessary to remove the globe for the pain of the condition, especially where it is useless as a visual organ.

OPERATIONS ON THE EYE AND ORBIT. For operations on the ocular muscles, lachrymal apparatus, eyelids, and interior of the eye the reader is referred to works on ophthalmology. The general surgeon will seldom do more than remove the eyeball or clear out the orbit (exenteration).

EXCISION OF THE EYEBALL (enucleation). *Indications.* For injuries where the globe is ruptured and collapsed ; where large foreign bodies are stuck fast in the globe and cannot be removed ; for penetrating wounds in the ciliary region, either at once when associated with other injuries so that recovery of useful vision is impossible, or later where iridocyclitis

has set in (from the danger of involvement of the sound eye with "sympathetic ophthalmia"); or where the eyeball is shrinking, painful, and useless after severe injuries; in excising a tumour of neighbouring parts where the eye cannot be left without much danger of recurrence.

In cases of glioma and melanotic cancer it seems questionable whether enucleation of the eye is sufficient, and it is more in accordance with our treatment of malignant disease elsewhere to remove the entire contents of the orbit in such cases.

Operation. The Vienna method is the simplest where the globe is unruptured. The patient is anæsthetized in the dorsal position, the eyelids
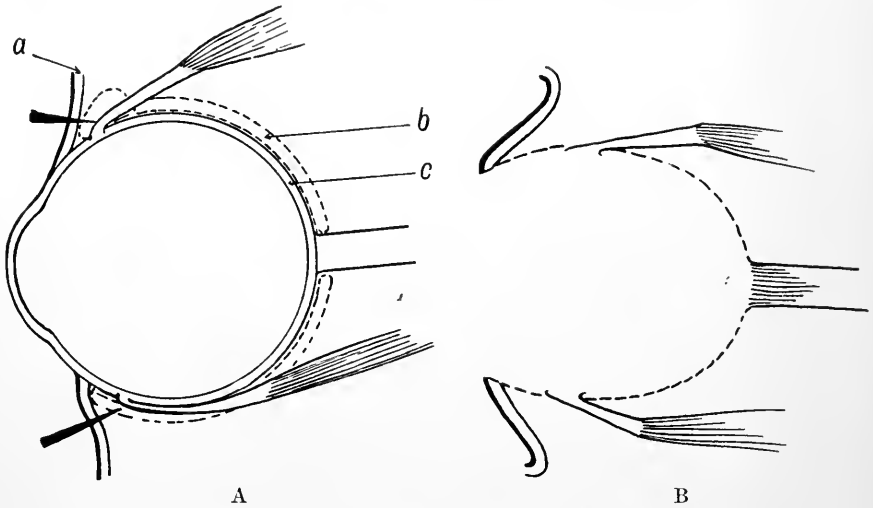
FIG. 115. Excision of the eyeball; showing the relations of Tenon's capsule, which is being opened above and below the cornea.
a, Conjunctiva. *b*, Space inside Tenon's capsule. *c*, Sclerotic. B, The globe enucleated; Tenon's capsule empty.

retracted with a spring speculum, and the conjunctival sac washed out with 1 in 5000 solution of biniodide of mercury. The conjunctiva at the inner side of the cornea and the internal rectus muscle lying under it are seized with toothed forceps and pulled up, the conjunctiva and muscle being divided behind or internal to the forceps, which maintains its grasp and retracts the eyeball outwards. Through the incision thus made the scissors are slid under the attachments of the superior and inferior rectus in turn and these divided with the overlying conjunctiva. The globe is pulled well out and the scissors passed behind the globe from within and the optic nerve divided; the external rectus, with the obliques and the rest of the conjunctiva, is then easily divided. Where the eyeball is collapsed it may be easier to snip through the conjunctiva all round, a quarter of an inch outside the corneal margin, pick up the muscles in turn with a squint-hook and divide them, cutting the optic nerve last of all. Bleeding soon ceases with moderate pressure, and a pad of gauze anointed with sterile vaseline to render subsequent dressings easier is bandaged over. An artificial eye may be ordered in three months.

EXENTERATION OF THE ORBIT. This is generally advocated for ocular tumours only when the latter have already spread to the orbit, but this is not in accordance with the treatment of malignant disease elsewhere. This treatment is certainly indicated where the orbit is invaded, but if practised while the growth is still confined to the globe it should give still better prospects of cure. The orbit is readily cleared by an incision round the

FIG. 116. Rodent ulcer (early).
(*Kindly lent by Dr. Gilbert Scott.*)

bony margins, stripping the periosteum from the walls and removing the contents in one mass ; any bleeding is checked by ligature or packing the cavity tightly with gauze. Later, when the cavity is granulating, it should be lined with Thiersch's skin-grafts.

SURGERY OF THE FACE

The integuments of the face are exceedingly well supplied with blood and heal very well after injuries or operations. Hence the face is well adapted for plastic operations, as the flaps require but a narrow pedicle to maintain their nutrition and this enables us to adjust such flaps more readily.

So good is the face at reparative efforts that where portions are cut off

by accidents (if cleanly done) it is well worth while to replace them. Thus the soft part of a child's nose was cut off by vigorous contact with a pane of glass; the loose portion was rescued from the dustbin, cleaned, and sutured in place. Some two-thirds maintained its vitality and remained *in situ*, leaving only the tip to be replaced.

The excellent anastomosis of the facial vessels has, however, this disadvantage, that it affords a ready means of spread of infection to the interior

Fig. 117. Rodent ulcer (advanced).
(*Kindly lent by Dr. Gilbert Scott.*)

of the cranium; and in this way severe infections, such as carbuncles or cellulitis of the face, may lead to thrombosis of intracranial sinuses or meningitis.

Of chronic inflammations, tuberculosis is commonly met with in the form of *lupus*, the healed scars of which are likely to become epitheliomatous even in young persons. Less commonly we find tuberculous abscesses, which take origin in the preauricular glands or in the malar-bone and maxilla.

Syphilis gives rise to many lesions on the face. Extragenital chancres are not uncommon on the upper lip, less so on the eyelids. The secondary rash is well marked on the forehead, mucous patches on the lips, and gummatous ulcers of the nose and forehead are typical. Another important

chronic inflammation is dry eczema associated with warts, fonnd on workers in tar and paraffin, which is likely to be the precursor of epithelioma.

NEW GROWTHS. Sebaceous cysts, dermoids and nævi, both capillary and cavernous, are common ; fibro-neuromas and cirsoid aneurysms are rare. Of malignant tumours epithelioma and rodent ulcers are common.

Rodent ulcers occur most often at the corners of the eyelids and the facio-nasal angle, and are characterized by their slowly progressing ulceration, indurated edge (sometimes healing in parts), infiltrated base, and absence of concomitant glandular enlargement. The spread eventually destroys the face, invading the orbit and nasal cavities, exposing the pharynx. Excision is best where it can be done freely without damage to important parts. In the latter condition X-rays, radium and cataphorsis with zinc, afford good results ; the application of solid carbon-dioxide is well reported, but we have found the results disappointing.

Epithelioma occurs often on the cheek or temple as an ulcer which advances fairly rapidly, has an everted, rolled edge, marked excavation of the floor (crateriform ulcer), indurated base, and early enlargement and induration of the lymphatic glands.

Treatment. X-rays are to be studiously avoided as likely to render the ulcer and the secondary glands worse. A wide local excision should be done, filling in the gap with a plastic flap, which can be readily fashioned from the face or neck. The area of lymphatic drainage should be carefully excised ; this may mean removal of the submaxillary gland and clearing the digastric triangle, or if the parotid glands are affected, these must be removed with the parotid salivary gland, which is a tedious dissection if the facial nerve is spared, but is by no means impossible, as we have found on trial.

SURGERY OF THE LIPS

INFLAMMATIONS. Fissures and cracks, which are really small ulcers, often form on the lips from irritation of a coryza or following herpes labialis, especially in the winter and in young persons. These cracks are likely to become chronic and lead to a certain amount of lymphatic obstruction, causing one variety of thick-lip (macrocheilia).

Treatment. Should these ulcers resist treatment with dilute nitrate of mercury ointment, they should be touched with the solid silver nitrate, and when this fails, excised and sutured.

Acquired macrocheilia arises from the above-mentioned ulcers and, as it is often found in children with definite signs of tuberculosis, is sometimes known as " strumous lip," but it is seldom a tuberculous condition.

A similar condition follows the cracked lips of congenital or acquired secondary syphilis, or may be due to gummatous lymphatic obstruction ; in these cases the treatment is specific.

Congenital macrocheilia appears to be a condition of lymphangeioma of the lip, and can be improved by excision of a wedge-shaped portion.

In addition to the primary and secondary manifestations of syphilis already mentioned (p. 372, also Fig. 118) gummata may also occur here,

and are distinguished from epithelioma by their punched-out appearance, less induration, greater vascularity, and absence of enlarged, hard lymph-glands; in doubtful cases a portion of the edge should be subjected to microscopical examination.

NEW GROWTHS OF THE LIPS. Capillary and cavernous nævi are common.

Retention cysts from blocking of mucous glands are found as small
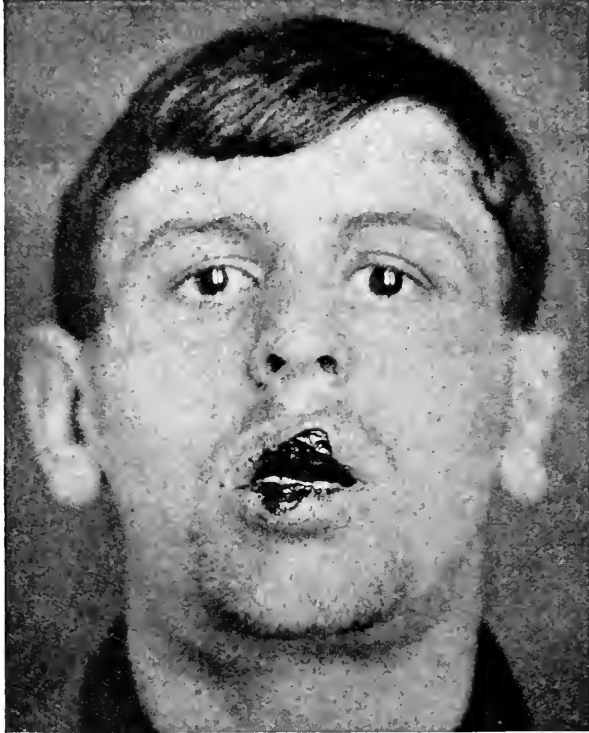
FIG. 118. Syphilitic chancres of the upper and lower lips; note also the enlarge-
ment of the submaxillary and submental lymph-nodes.
(*Kindly lent by Dr. Gilbert Scott.*)

translucent swellings on the inner side of the lip : removal of the outer wall of the cyst suffices for cure.

CANCER AND ALLIED CONDITIONS. Leucoplakia, or patches of thickened epithelium resting on a basis of hypertrophied papillæ, are found inside the lips and cheeks just as they are on the tongue. These may persist unchanged for years, but in many instances are the originating point of squamous-celled cancer, and hence are best removed.

Warty growths may start in patches of leucoplakia or independently of these. From well-defined cancer they may be distinguished by the want of surrounding infiltration and of glandular enlargement; but from early cancer, in which these points are slight, diagnosis may be impossible, and hence all warts should be removed at once and examined microscopically, and should the condition prove to be cancerous a wider excision practised.

CANCER (EPITHELIOMA) OF THE LIP. This is of the squamous-celled variety containing well-marked cell-nests. The growth occurs usually on the lower lip in men and is uncommon under forty. A common cause is the use of a clay-pipe, and when occurring in women it is usually due to this. The cancer commences as a crack or wart on the side where the pipe is held and spreads around the mouth as an indolent, indurated ulcer in the direction of the orbicularis muscle, till there may be finally a fungating mass surrounding the mouth. Secondary deposits are very late to appear in the submental and submaxillary glands, and this is on the whole a very benign type of cancer.

Diagnosis. Warts cannot be distinguished from early cancer, and should be removed and subjected to microscopical examination. Labial
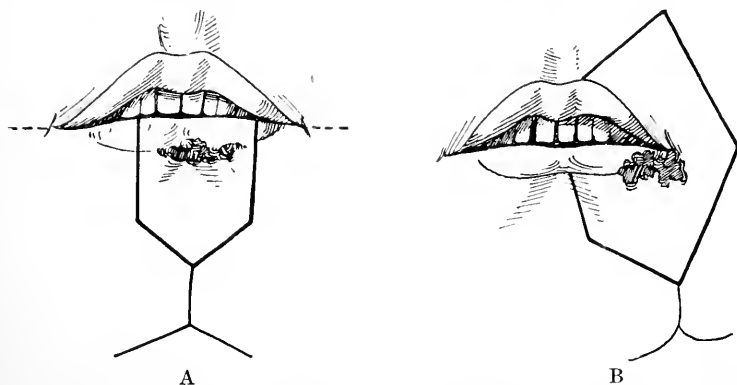
FIG. 119. A, Excision of an epithelioma of the lower lip. B, Excision of an epithelioma of the angle of the mouth. (After Jacobson.)

chancres are often mistaken for cancer, but occur most often on the upper lip in women, there is far more œdema around, the growth is more rapid, and the glands of the submaxillary triangle are enlarged in a few weeks, while the Wassermann reaction will be of assistance.

Treatment. The growth should be removed widely with the area of lymphatic drainage. As the local spread is along the orbicularis it is not enough to remove a mere V-shaped wedge, but the incisions should pass down at right angles to the margin of the lip and include half an inch of normal tissue. In early cases this, with removal of the submental glands, will suffice. Where the cancer has been present for some while the operation should be on a larger scale. The incisions do not meet till the chin is reached, and are then carried out over the submaxillary triangles of one or both sides (according to the position of the cancer), and one or both anterior triangles are cleared out, including the submaxillary, salivary and lymphatic glands as well as all the fat, and the whole mass with the lip removed in one piece. In severe, widespread cases a portion of jaw must be removed as well. The operation is finished by making plastic flaps from the neck to fill in the gap.

CHAPTER XXVII

SURGERY OF THE NOSE, NASOPHARYNX, AND ACCESSORY SINUSES

Anatomy of the Nasal Cavities : Examination of the Nose : Injuries of the
Nose : Deformities of the Nose : Destruction of the Nose : Foreign Bodies in
the Nasal Cavity : Rhinoliths : Affections of the Nasal Septum : Epistaxis :
Ulceration of the Septum : Acute Rhinitis : Atrophic Rhinitis : Hypertrophic
Rhinitis : Nasal Polypi : Malignant Tumours of the Nasal Cavity : Anatomy
of the Accessory Sinuses : Examination of the Accessory Sinuses : Affections
of the Maxillary Antrum, of the Frontal Sinus, of the Anterior Ethmoidal
Cells, of the Sphenoidal Sinus, of the Posterior Ethmoidal Cells : The Naso-
pharynx : Adenoids : Tumours of the Nasopharynx.

ANATOMY.   The nostrils lead into the nasal cavities, which communicate
behind with the nasopharynx by the posterior nares.   The external nose
is stiffened by the nasal bones and the nasal process of the superior maxilla,
while the soft part contains the end of the septal cartilage and the lateral
cartilages ;   the skin about the entrance of the nostrils contains many
sebaceous glands, which if inflamed form boils.   The interior of the nasal
cavity is divided by the septum, which is made of the septal cartilage, the
vertical plate of the ethmoid, and the vomer, and is covered with muco-
periosteum, which can be readily stripped from the underlying bony or
cartilaginous framework.   The upper boundary of the nasal cavity is the
cribriform plate of the ethmoid, through which the olfactory nerves pass
out of the skull.   The outer wall abuts, above on the ethmoidal cells and
orbit, below on the antrum of Highmore in the maxilla.   From this wall
the thin curled, shell-like, turbinate bones project into the nasal cavity,
and are covered with mucosa, which in the case of the middle and lower
turbinates is so vascular as to be practically erectile.   There are several
openings in this outer wall.   Covered by inferior turbinate is the opening
of the nasal duct leading from the conjunctival sac, which may become
occluded from inflammatory conditions of the nose and thus cause epiphora,
&c.   The middle turbinate overlies some important structures : immediately
to its outer side is a projection of the ethmoid called the ethmoidal bulla,
below which is a depression, the hiatus semilunaris, into the front end of
which the frontal sinus debouches by the long infundibulum ; more posteriorly
is the opening of the antrum of Highmore, while between the two are the
openings of the anterior and middle ethmoidal cells.   Beneath the superior
turbinate is the opening of the posterior ethmoidal cells, and just behind
this, in the nasopharynx, is the opening of the sphenoidal cell (Fig. 128).

The passages below the turbinates are known respectively as the superior,
middle, and inferior meatuses of the nose.

The nasopharynx is situated immediately behind the nasal cavity, above the level of the palate ; it is bounded above and behind by the basisphenoid and basi-occipital bones, which can here be palpated, while on its lateral walls are the openings of the Eustachian tubes, level with the inferior meatus of the nose, and behind these the depression or fossa of Rosenmuller, into which branchial fistulæ may open at their upper termination (p. 366).

EXAMINATION OF THE NASAL CAVITIES. In many instances the history will not point to any nasal disorder but rather to the ear, pharynx or larynx, such symptoms as deafness, noises in the head, dryness of the throat, hoarseness, &c., being complained of, and yet the main cause often is some abnormal condition of the nasal cavities. Hence a routine examination of the interior of the nose is essential in affections of the ear and throat. The symptoms may point directly to the nose, such as nasal obstruction, which is tested by occluding the nostrils in turn and watching the power of breathing in and out of the free nostril. Such blocking may be unilateral, from deviation of the septum, spurs, enlargement of the turbinates, polypi, rhinoliths, crusts, &c., or bilateral, from adenoids, polypi, or growths of the nasopharynx. There may be discharge of pus or blood (epistaxis) from one or both nostrils or formation of crusts in the nasal cavity, and fœtor of the breath may lead to advice being sought.

The nasal cavity may be inspected from in front or behind.

(1) Anterior rhinoscopy is done by dilating the nostril with a non-fenestrated speculum to push aside the vibrissæ, and examining with light reflected by means of a laryngoscopic head-mirror. The anterior portions of the inferior and middle turbinates can be seen and part of the septum. Enlargement of the former and deviations or spurs of the latter are noted, as well as polypi or crusts ; and after cleaning out the interior by swabbing it can be seen whether any discharge of pus is general or comes from under or above the middle turbinate. Where the turbinates are very large the interior should be painted with equal parts of 10 per cent. cocain and adrenalin 1 in 1000 solution, which cause the hyperæmic mucosa to shrink, allowing a clearer view. Where the mucosa and turbinates are atrophic the posterior wall of the pharynx may be seen from in front, and even the opening of the sphenoidal sinus noted, while the bulla ethmoidalis may be mistaken for the middle turbinate. The probe will afford some guide as to the consistence and relation of polypi, &c., and operations on the septum and turbinates are carried out after anæsthetizing and devascularizing the parts in this manner (Fig. 129).

(2) Posterior rhinoscopy consists in introducing a small mirror—similar to that used for examining the larynx but much smaller (size 0 to 00) and set at more nearly a right angle on its handle—behind the soft palate, and observing the reflection of the posterior nares, &c., by means of light reflected with a laryngoscopic head-mirror. The patient is told to breathe quietly through the nose in order to bring the soft palate away from the posterior wall of the pharynx, and if the throat be irritable cocain is applied. The

posterior choanae, septum and posterior parts of the superior and middle turbinates are seen, but the inferior only when hypertrophic. In addition the roof of the nasopharynx and adenoids or tumours may be noted, and the Eustachian tube on either side.

(3) *Digital Examination of the Nasopharynx.* Most of the points mentioned in the last section may be felt with the finger, and this method is useful when examining children for adenoids, as, though less pleasant than posterior rhinoscopy, it takes 'less time. The finger is made to slide past the tonsil, hooks the soft palate forwards, and glides into the naso-pharynx. Care must be taken to avoid being bitten as the finger is withdrawn ; the simplest plan is to push a fold of the patient's cheek be-tween the teeth with the other hand, which effec-tually prevents the finger being caught.

Diagnostic puncture and irrigation of the accessory sinuses are de-scribed later (p. 390).

INJURIES OF THE NOSE. Fractures of the nasal bone result from blows

FIG. 120. Posterior rhinoscopy.

and falls on the bridge of the nose. In the slighter examples the lower ends of the nasal bones are broken off, causing pain, swelling and crepitus to be noted, but there is little displacement, and such cases heal without treatment other than rest and with practically no deformity. Where the fracture is higher up and caused by greater violence the nasal bones may be driven back into the nasal cavity and the nose flattened on the face. In such cases there is always some injury to the nasal septum, which is bent or broken across, and a hæmatoma of the septum may result from effusion of blood beneath the perichondrium. The flattened, mobile nose renders diagnosis obvious.

Treatment. The shape of the nose is restored by pushing the fragments outward again with some blunt instrument introduced into the nasal cavity under guidance of vision, an anæsthetic being usually advisable. The reduced fragments will often retain their position, but it will be advisable

to pack the interior with sterile vaselined gauze for a couple of days and place a splint of moulded poroplastic over the front of the nose to prevent further displacement. Union will be tolerably firm in a week. Care is taken to restore the septum to its proper position, or there may be considerable impairment in the calibre of the nasal passages and flattening of the bridge. Where there is a large hæmatoma of the septum it may as well be evacuated under aseptic precautions, as if left it may suppurate and lead to sloughing of the septal cartilage and falling in of the bridge of the nose.

DEFORMITIES OF THE NOSE. The nose may be flattened from injuries as mentioned or as the result of disease of the septum which is most commonly syphilitic, both congenital and acquired. In the former condition the bridge of the nose is sunken and flattened, but the tip stands out (saddle-nose); in the latter case the whole nose may be level with the rest of the face.

Treatment. Various methods are employed to restore the projection of the nose. Paraffin-wax may be injected in the molten state and moulded

FIG. 121. Microscopic section of a case of rhinophyma. Note the massive overgrowth of the subaceous glands and excess of fibrous tissue.

into form before it solidifies, protheses of aluminium or vulcanite are introduced under the skin, or plastic operations combined with bone-grafts employed.

Widening of the base of the nose is often noted in tumours of the nasopharynx, which are mostly fibro-sarcomas.

The skin and tissues of the nose are often the seat of ordinary inflammatory conditions, such as boils, lupus, lupus erythematosus, syphilitic ulcers, &c., and demand no further mention.

The condition *rhinophyma*, however, is worthy of a few remarks. This affection, which is also known as " hammer-nose," consists of a hypertrophy of the sebaceous glands of the soft part of the nose, together with overgrowth of the surrounding connective tissue and dilatation of the capillaries—the whole presenting itself in advanced cases as a bulbous, corrugated, purple

mass, like a bunch of over-ripe strawberries attached to the nose; the orifices of the enlarged glands plugged with secretion are very obvious.

Treatment. This disfigurement is readily dealt with by the knife, the organ being pared down to cosmetic proportions, cutting away redundant tissue but avoiding the cartilages. The raw surface is soon covered with
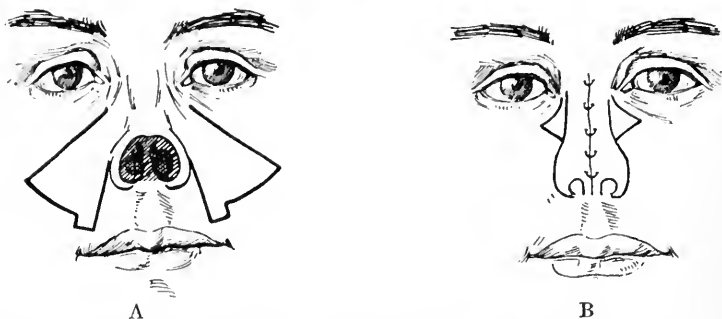
Fig. 122. A, Flaps to repair loss of the soft part of the nose. (After Syme.)
B, Suturing of the nose.

new epithelium and, though rather scarred, is far more sightly than the original excrescence.

DESTRUCTION AND LOSS OF THE NOSE. This may result from injury or such diseases as sloughing gummata, lupus, rodent ulcer, &c., and as the appearance is very unsightly, steps must be taken to fill the gap. The best plan, as far as appearances go, is to have an artificial nose made of aluminium, coloured to the complexion of the patient, fixed on with a pair of spectacles, the junction being obscured with a little grease-paint. This applies to loss of the whole nose, but where the loss is partial, or the patient, from motives of expense or feeling of ownership, desires to have a nose of

Fig. 123. Flap to replace partial loss of the nose.

his very own which cannot fall off at inconvenient moments, some plastic operation will be needed.

(*a*) Where the soft part only is missing it may be replaced by flaps from the cheeks with the base upwards (Syme) (Fig. 122).

(*b*) The tip can be restored by flap from one cheek with the base down (Fig. 123).

(*c*) The Indian method for restoring the whole nose consists in turning a flap down from the forehead, but the resulting nose is very flabby and needs stiffening, as follows :

(*d*) Keegan's method is suitable where the nasal bones and the skin over them are intact (*e.g.* in cases due to mutilation). The skin covering the nasal bones is first turned down to form the lining of the new nose and give it thickness; then a flap is brought down from the forehead, as in the Indian method, to cover the raw surface of the nasal bones and of the turned-down flap. The flaps are cut fully large and allowance made for the alæ nasi and columella. This plan has the

advantage of giving a lining for the nose and is less liable to contract than the original Indian method (Fig. 124).

(e) Where the bridge is also deficient a new one must be provided by placing a bone-graft in the forehead (this may be taken from a rib), and when this has taken sound root (three weeks) turning down the flap from the forehead with the bone-graft, which thus forms a firm bridge (Fig. 125). The Italian method, where a graft is taken from the arm, is too tedious for the patient, who must be confined with the arm to the nose in plaster for some

A   B
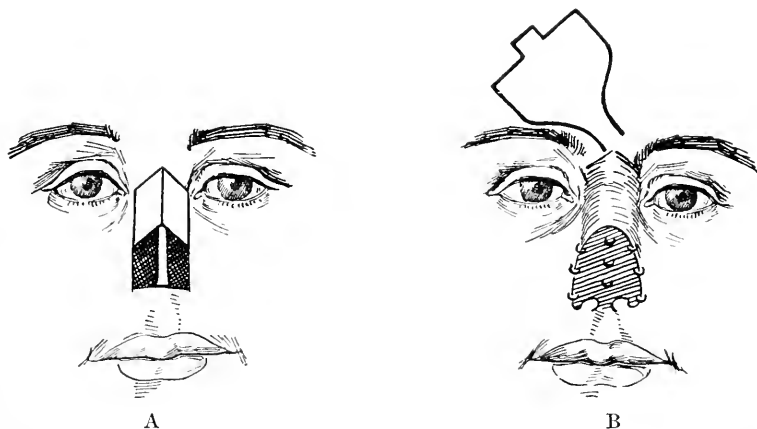
Fig. 124. Keegan's modified Indian method of reforming the nose. A, turning down skin-flaps from the bridg e of the nose. B, Superimposing a flap from the forehead on the previous flap (the forehead flap is represented too small).]

weeks, and the same applies to the plan of transplating a finger to make a new nose, besides the doubtful benefit of losing such a useful appendage as a finger to form a purely ornamental excrescence.

SURGERY OF THE NASAL CAVITIES

FOREIGN BODIES. These are in most instances introduced experimentally by children—beans, buttons, and beads being favourite objects. The child may be brought up soon after the body has been inserted or this history may be wanting, and later the foreign body causes irritation, ulceration, unilateral discharge of pus and blood, and unilateral nasal obstruction. These signs occurring in a child suggest at once the presence of a foreign body and the need for careful local examination.

Treatment. These cases should be investigated under a general anæsthetic, the nasal cavity being packed with adrenalin and cocain solution on gauze. Foreign bodies, when seen, are removed with a small blunt hook or a suitably bent probe ; forceps are seldom suitable.

RHINOLITHS. In addition to bodies introduced from outside, calcareous concretions form about crusts in the nose in cases of chronic rhinitis, and are removed in a similar manner. They may be taken for bony sequestra

or malignant growths, owing to the discharge and granulations set up by their irritating presence.

AFFECTIONS OF THE NASAL SEPTUM. *Injuries* and resulting *deviations* and *spurs*.

Mention has already been made of the manner in which the septum may be bent or broken in cases of violence applied to the nose, or how hæmatomas may arise. The later results of hæmatomas and minor degrees of violence are the formation of spurs or lateral projections from the septum or deviation of the latter, in which case it is relatively too long for its bed and curls up, bulging into one or other nasal fossa, sometimes into both. The result of such projections and deviations is to diminish the calibre of the nasal channels, thus causing nasal obstruction and leading to breathing through the mouth in the more severe cases, and as a result of this to affection of the pharynx and larynx, so that the patient often complains of dryness of the throat, though difficulty of nasal respiration may be also a complaint. Congenital defects may account for some of these conditions.

FIG. 125. Repair of the nose by the Indian method of a flap from the forehead, modified by previously placing a bone graft in the forehead to give rigidity.

Diagnosis. This is made by anterior rhinoscopy. Spurs are solid projections from one side of the septum. Deviations are seen as projections into one nasal fossa with a corresponding concavity in the other, on which side also the turbinates are usually enlarged to reduce the cavity.

Treatment. When causing nasal obstruction or trouble further down the respiratory tract, in the larynx, pharynx, lungs (*e.g.* laryngitis, dry throat, asthma, &c.), these obstructions should be removed.

The mucosa is rendered avascular and insensitive by carefully packing with strips of gauze soaked in a mixture of 10 per cent. cocain and 1 in 1000 adrenalin. Many surgeons use no general anæsthetic, as this causes more bleeding and renders the operation more difficult. Spurs may be removed with saw or chisel, cutting away the mucosa over them, or more neatly by first stripping the mucosa, then cutting away the spur and replacing the mucosa.

Deviations are corrected by removing the septal cartilage and bone of the septum as far as is needed entirely to correct the deviation, but leaving the mucosa quite intact on one side, while only dividing it on the other to afford sufficient room to strip the cartilage.

Through a small incision the mucosa is stripped from one side of the septum; the cartilage is then carefully cut through and the other side stripped, avoiding injury to the mucoperichondrium on the far side. Keeping the mucosa away from the denuded septum with Killian's long speculum, the latter is cut away with a swivel-knife and the bony portion removed with

punch-forceps and chisel as far as is necessary to secure complete correction. A gauze pack is left for three days in either nasal cavity to bring the septal mucosa into the middle line.   If the mucosa is perforated on the second side a perforation will probably remain in the septum, which causes annoyance by collecting crusts.¶

EPISTAXIS, OR BLEEDING FROM THE NOSE. This may result from injuries of the interior of the nose, including fractures of the base of the skull (cribriform plate). It is not uncommon with infective conditions such as pneumonia, enteric ; in blood diseases, as purpura, leukæmia ; in disturbances of blood-pressure of cardiac and renal disease ; but by far the commonest source of spontaneous epistaxis is a small ulcer situated on the anterior part of the septum, caused by picking and scratching to relieve irritation of the part. The ulcer may be pin-point in size, and yet hæmorrhage is often severe and continuous, as small arteries are apt to be involved in the ulcer. The bleeding is usually unilateral.

Treatment. Owing to the anterior position of the ulcer on the septum, bleeding can usually be controlled by compressing the lower part of the nose close to its origin from the face, and if this be done and the patient kept sitting up bleeding will cease in a short time. Where epistaxis continues local inspection (anterior rhinoscopy) must be made, first packing the nose with adrenalin and cocain, which will cause temporary cessation of bleeding, and on inspection the small ulcer will be seen and sealed with the electric cautery or a bead of chromic acid fused on a probe. If picking be then avoided the ulcer will heal ; accumulation of crusts is prevented by inserting ammoniated mercurial ointment.

Where the bleeding is general, persistent, and not from such an ulcer the nasal cavities are systematically packed from in front with adrenalin gauze, packing between the turbinates and the outer wall as well as between the former and the septum. The nose can be well packed from in front, and the method of plugging the posterior nares by means of Belloc's sound only results in the retention of septic clots in the nasal cavity and is most uncomfortable.

ULCERATION OF THE SEPTUM. Lupoid and tuberculous ulcers are treated by curetting and cauterizing with lactic or chromic acid.

Gummatous ulcers may occur, and need general antisyphilitic measures, removal of sequestra, and antiseptic dressing.

Epithelioma and sarcoma require free excision, turning up the mask of the face from inside the mouth or temporarily reflecting the upper jaw (*see* Operations on the Naso-pharynx).

INFECTIONS OF THE NASAL MUCOSA (rhinitis). The whole mucosa may be infected, but owing to the soft, pulpy nature of the part covering the turbinates, the results are more obvious in this region and the after-effects more pronounced.

Acute rhinitis (coryza, cold in the head) is caused by infection with various organisms, including B. catarrhalis, streptococci, pneumococci, and rarely gonococci. The infection tends to spread to the accessory

sinuses in the frontal ethmoid and maxillary bones, accounting for the head- and face-aches often associated with this infection. The infection usually clears up spontaneously after passing the various stages of œdema of the mucosa, in which the nose feels dry and is blocked, through that of a muco-purulent catarrh, to profuse watery catarrh with relief of symptoms. As the nasopharynx is usually affected at the same time, the Eustachian tubes are often blocked, causing temporary deafness. Where blocking of the orifice of an accessory sinus takes place the infection may run a more severe course and empyema of the sinus result. From repeated attacks the turbinates may become enlarged and hypertrophic as regards their mucosa ; finally the underlying bone may become affected and polypi result. Treatment is seldom needed in the acute stage except to relieve the headache and sensation of blocking of the nose. This may be achieved

FIG. 126. Deviated nasal septum. Section through nasal fossæ, showing the curved septum, the turbinates enlarged on the concavity and atrophic on the convexity.

by spraying the nose and throat with menthol and eucalyptus āā. twenty grains dissolved in parolein one ounce.

The action of cocain and adrenalin is more powerful but causes much dryness and discomfort afterwards. Prophylactic doses of vaccine are used by some, but the period of immunity thus conferred seems to be very short. Where repeated attacks of coryza occur the nose and nasopharynx should be examined, especially in children, as adenoids are often a potent predisposing factor ; while deviations of the septum or chronically enlarged turbinates may be found and corrected.

The condition *hay fever*, due to irritation with the pollen of grasses, &c., is also increased by such defects, and their removal will often improve matters greatly.

Rhinitis, due to infection with the Klebs-Löeffler bacillus (diphtheria), is not uncommon in children, and may be suspected in cases of acute coryza where there is much blocking of the nose and foul-smelling discharge, while if a false membrane be found the probabilities are still greater, and a dose of antitoxic serum should be given at once while the discharge is being tested for the organism.

CHRONIC RHINITIS. In addition to the specific infections of syphilis and tubercle there are two varieties of chronic rhinitis of uncertain origin, the *atrophic* and the *hypertrophic*.

Syphilitic rhinitis occurs in the congenital and acquired forms of the disease. In infants " snuffles " is a common symptom of congenital syphilis, and in addition to the catarrh there may be destruction of part of the septum, leading to the condition of " saddle-nose." In the acquired form gummatous ulcers of the septum and ethmoid, with necrosis and falling in of the whole nose, is the usual condition. While ulceration is still in progress there will be collections of crusts and sequestra inside the nasal cavities,

causing the breath to be most offensive and constituting one form of " ozæna."

Treatment is specific, as well as by removing crusts, sloughs, sequestra, washing out the nasal cavities and generally promoting nasal asepsis.

Tuberculosis of the nose may be secondary to the lungs or arise from spread of lupoid ulceration of the face ; in either case the septum is the part most affected. Curetting away granulations and painting with strong lactic-acid solution will promote recovery.

ATROPHIC RHINITIS (rhinitis sicca, ozæna). The origin of this condition is obscure ; it arises quite apart from acute rhinitis and the hypertrophic form, most usually in young anæmic females with wide nostrils, large nasal cavities, and turned-up nose. A chronic catarrh of the mucosa leads to a viscid, muco-purulent discharge which, owing to the width of the nasal channel, cannot easily be expelled on blowing the nose and dries in crusts on the inner surface of the nasal cavity. In addition to the catarrh the mucosa becomes thinned and atrophic and the turbinates small and shrunken, rendering the nostril still more void and the condition worse. The crusts putrefy and stink unless removed, the stench being very apparent to observers but unnoticed by the patient either from force of habit or atrophy of the olfactory mucosa. The patient usually comes for advice because others complain of the foul breath, or less often because the nose is obstructed with crusts. Examination, after crusts have been removed, reveals a thin anæmic mucosa and atrophic turbinates, while the posterior wall of the pharynx is

FIG. 126A. Section of nasal fossæ. a, Normal, compare with b (atrophic rhinitis), with atrophied turbinates, roomy cavity, and the ostium of the sphenoidal sinus readily visible.

generally visible through the wide nasal cavity. Search must be made for suppuration of accessory sinuses, which may be the origin of this condition.

Treatment. The crusts are removed (after softening by packing with gauze soaked in 5 per cent. menthol in parolein) ; after picking out all crusts the nose is kept packed with gauze and daily irrigated with 2 per cent. solution of sodium bicarbonate, which converts the condition from a stinking ozæna to one of simple atrophic rhinitis without crusts, a far less unpleasant condition for the associates of the patient. Probably nasal irrigation and partial packing with gauze will have to be kept up for the rest of the patient's life. Attempts have been made to diminish the size of the nasal cavities by injecting molten hard paraffin under the mucosa and thus forming false turbinates, but if the formation of crusts be prevented and the nose kept clean most patients will be content.

HYPERTROPHIC RHINITIS. This affection is characterized by increase in thickness of the mucosa of the turbinates, which becomes soft, pulpy, and more vascular. Though associated with and a predisposing cause of inflammation, we may doubt to what extent this condition is really an inflamma-

tory state ; it seems more allied to hypertrophy of the tonsils and of adenoid vegetations. The condition usually affects young adults, but in middle age may be found associated with suppuration of the accessory sinuses. Nasal polypi may be an exaggerated form of the affection, the mucosa being very œdematous and forming polypoid excrescences.

Signs. Excessive secretion of a watery nature, frequent attacks of coryza, and nasal obstruction of varying degree, the difficulty of breathing through the nose causing mouth-breathing, which is followed by irritation and inflammation of the pharynx and larynx, asthma, &c. In cases of a deviated septum the turbinate on the concave side may be enlarged by compensation to diminish the over-wide airway. On rhinoscopy the enlarged and swollen turbinates will be seen pushing against the septum and the enlarged, posterior end of the inferior turbinate may be seen as a polypoid mass by posterior rhinoscopy. From the middle turbinate, dependent polypoid masses may be seen. The use of the probe will distinguish from solid tumours, while the shrinkage after application of cocain and adrenalin is characteristic of the hypertrophied mucosa.

Treatment. The slighter cases will be relieved by avoiding dusty atmospheres and excessive smoking, washing out the nose with dilute alkaline solution (*e.g.* ten grains sodium bicarbonate, three grains of carbolic acid to an ounce of water), maintaining free action of the bowels and attention to the general health. Where in spite of these measures the condition persists, especially where it is leading to trouble in the lower respiratory tract, laryngitis, asthma, &c., the nasal passages must be rendered more open. Any deviation or spur of the septum should be treated, and if this be not enough the inferior turbinates may be seared longitudinally with the electro-cautery, which will cause fibrosis and shrinking, or the posterior end if enlarged may be excised with the snare. If the cautery be used care is taken not to touch the septum as well or adhesions will form across the nasal cavity, causing worse blocking than before. The inferior turbinate should never be removed completely or the cavity may become too wide and formation of crusts and ozæna follow. The middle turbinate, if very large, may be removed entire with the snare or the anterior third cut away from its attachment with scissors and then removed with a snare. Removal of turbinates should not be done in too whole-hearted a manner lest the cavity become too wide and ozæna follow.

Nasal Polypi. These greyish, rounded, translucent masses nearly always grow from the middle turbinate or middle meatus, occasionally from the superior turbinate, never from the inferior and very rarely, if ever, from the septum. Fibrous polypi seldom grow from the nasal cavity but from the roof of the nasopharynx. The cause and nature of polypi are not altogether clear : it is generally admitted that they are due to a condition of hypertrophic, œdematous mucosa and are not new growths (myxomas), as has been thought, and hence may be regarded as an advanced condition of hypertrophic rhinitis. In a good many instances they are associated with chronic suppuration of the accessory sinuses, and sometimes with

inflammation and rarefaction of the underlying bone, though whether this is a cause or consequence of the polypi is uncertain. This rarefaction of the underlying bone, "ethmoiditis," is regarded with suspicion by modern pathologists.

Signs. Nasal obstruction, often unilateral, excessive secretion of watery mucus, notably in damp weather, and secondary affections of the lower respiratory tract, laryngitis, asthma, &c.

Diagnosis. The grey, translucent mass of a polypus is unmistakable if properly seen (the nasal cavity must be cleaned out and cocainized to ensure a proper examination) ; the probe will show the softness and mobility of the tumours and that they are pedunculated.

Treatment. Removal of the polypi with the cold snare under cocain is the usual plan. As they spring from the middle turbinate and recur repeatedly, the base from which they spring should be cauterized or, better, more or less of the middle turbinate removed with scissors and snares, and small polypi removed with a curette, especially as this affords access to the openings of most of the accessory sinuses ; and if there be (as is not infrequent) suppuration in the latter, removal of the middle turbinate will be a necessary part of the treatment of the underlying condition. After removal the cavity is packed with gauze for two days and then washed out with alkaline lotion.
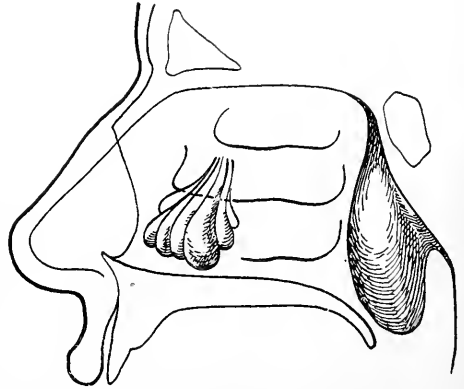
Fig. 127. Diagram of nasopharynx, showing a soft nasal polypus growing from the middle turbinate and a fibrous polypus growing from the back of the nasopharynx.

MALIGNANT TUMOURS OF THE NASAL CAVITY. Squamous-celled cancer (epithelioma) is occasionally found, producing discharge of blood and pus from one nostril and blocking of the latter. On examination a polypoid granulation-like mass will be found in a middle-aged person, and the diagnosis is confirmed by removing a piece for microscopical section. Where the condition is cancerous, removal may be attempted in suitable instances by one of the methods described below for obtaining ingress to the nasal fossæ. Sarcomas are also found occasionally, presenting themselves as fibroid polypi. Local removal, combined with heavy doses of X-rays, is worth a trial, since very wide removal is no more likely to be successful if the condition really is a sarcoma, while if of the " recurrent fibroid " type local removal is enough.

FUNCTIONAL DISORDERS. *Anosmia,* or loss of the sense of smell, may be due to injuries of inflammations, *e.g.* ozæna, influenza, &c.

Parosmia, or perverted sensation of smell, is found in cases of sinus suppuration.

Reflex disorders are sometimes due to nasal defects; amongst these we have mentioned asthma, but epilepsy, dyspepsia, &c., are also attributed to deviations of the septum, enlarged turbinates, &c., and sometimes with justice, though many of these so-called secondary effects rest on the mental bias of the observer.

AFFECTIONS OF THE ACCESSORY SINUSES OF THE NOSE

ANATOMY. (1) The frontal sinuses are situated in the frontal bone on either side of the root of the nose. They lie between the inner and
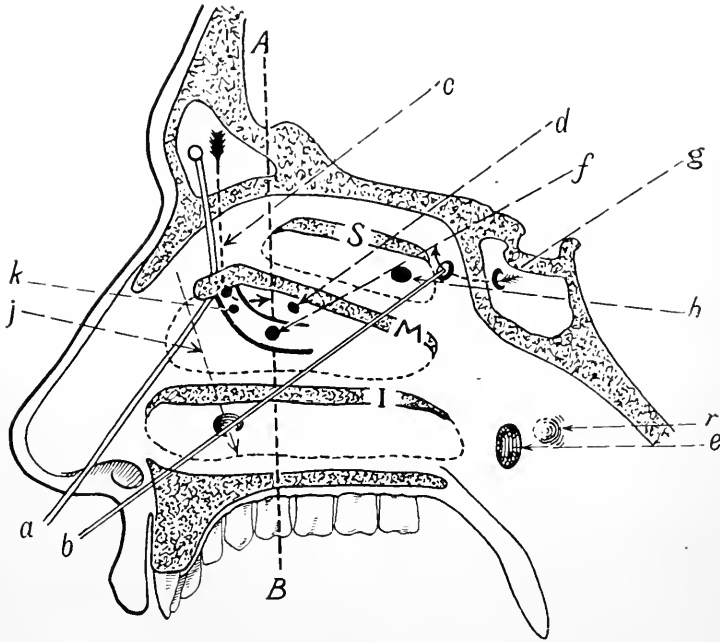
FIG. 128.   Diagram of sagittal section of skull, showing the outer wall of the nasal fossa, &c. The turbinates have been cut off.   a, Probe passed into the frontal sinus up the infundibulum.   b, Probe in the sphenoidal sinus.   c, Direction of the infundibulum ending in the hiatus semilunaris.   d, Opening of the mid-ethmoidal cells on the ethmoidal bulla.   e, Eustachian tube.   f, Opening of the antrum of Highmore into the hiatus.   g, Sphenoidal sinus and its ostium.   h, Opening of posterior ethmoidal cells.   k, Opening of anterior ethmoidal cells.   r, Recess of Rosenmüller.   S, Superior turbinates.   M, Middle turbinate.   I, Inferior turbinate.   A, B, Line of section in Fig 130.

outer tables of the skull in the situation elsewhere occupied by the diploe, the wall of the sinus being of dense bone. They are related in front to the forehead, below to the orbit, and above to the anterior fossa of the skull. The anterior wall is the thickest and the orbital the thinnest, so that if expansion occur it will compress the orbit. The sinuses are of variable size and often asymmetrical, so that one encroaches over the middle line into the territory of the other. The average dimensions are (Turner), height, an inch and a quarter; width, one inch; depth, three-quarters of an inch. They communicate with the middle meatus of the nose by a

passage (the infundibulum), which leaves the frontal sinus at the inner part of its floor.   The floor of the sinus is in close relation with the anterior ethmoidal cells, hence these are often affected in conjunction with the frontal sinus.

(2) The ethmoidal cells are mesial to the orbital plate of the ethmoid and form the lateral mass of the bone ; the middle ethmoidal cells project as the bulla ethmoidalis into the middle meatus of the nose.

(3) The sphenoidal sinus lies in the body of the sphenoid ; it is related above to the sella turcica in the anterior fossa of the skull, which contains the pituitary body, in front to the nasal fossæ, below to the roof of the nasopharynx and base of the vomer.   The opening or ostium of this sinus is in the anterior wall, and is indicated by a straight line passing up from the anterior extremity of the floor of the nasal fossa, crossing the middle of the interior turbinate, at the point where this line strikes the upper posterior part of the nasal cavity.

The maxillary antrum (antrum of Highmore) is situated in the body of the upper jaw and of pyramidal shape, the base being against the outer wall of the nasal cavity, the apex lying under the malar-bone.   The antrum is related above to the orbit, below to the palate, inside to the lateral wall of the nasal cavity, behind to the sphenomaxillary fossa.   The floor is in relation to the roots of the bicuspid and molar teeth (hence the liability of the sinus to be infected from caries of the former, while dental cysts may encroach on the sinus).   The ostium, or opening, is high on the inner wall into the middle meatus of the nose, at the posterior part of the hiatus semi-lunaris ; being far above the floor, it is in a bad position for drainage ; there is often a secondary ostium leading into the middle meatus in a more posterior position.

EXAMINATION OF THE ACCESSORY SINUSES.   The affection most commonly occurring in these sinuses is chronic suppuration ; retention of non-purulent exudate (mucocœle) as well as malignant and other forms of new growth also occur.   As has been mentioned, four of the accessory sinuses open into the hiatus semilunaris of the middle meatus, viz. the anterior and middle ethmoidal, the frontal and maxillary sinuses, while two open into the superior meatus, viz. the posterior ethmoidal and sphenoidal.

When, therefore, there is unilateral suppuration of the nasal cavity, the external lateral wall should be cleaned and, after waiting a few minutes, search made for the point of exit of the pus.   If a trail of pus runs down over the inferior turbinate from the middle meatus, one or more of the first group of sinuses is affected, but should the pus track down in the olfactory fissure running over the middle turbinate, it comes from one of the two latter, and may also be noted by posterior rhinoscopy (Fig. 129).

In addition to or apart from the complaint of a discharge of pus from one nostril, attention will be called to headache, pain in the face and fore-head (especially in frontal or maxillary suppuration), dryness of the mouth, nose, pharynx, and hoarseness ; while if there is retention of muco-pus

the sinus may become distended and bulge on the exterior, or where the inflammation is more acute there may be a patch of boggy, red, œdematous skin, just as there is in suppuration of the mastoid antrum. Nasal polypi will not infrequently be noted. To determine which sinus or sinuses are affected, it is best to proceed by the method of exclusion. The antrum of Highmore is the sinus most often affected, and to determine if pus or other matter is filling the sinus we may place the patient in a dark room and transilluminate the sinus by means of a small lamp placed in the mouth. Normally light shows through the hollow antrum, but if filled with pus or growth it is opaque; thickening of the bone, however, may cause similar opacity. A better plan is to insert an aspirating-needle (four inches long and of medium calibre) into the antrum. After cocainizing the outer wall of the nasal cavity, the needle is thrust outward below the middle of the inferior turbinate, where the antral wall is thin; the sinus is then washed out and the efflux caught in a receiver, when the presence of pus is readily noted. If no pus be found the antrum may be regarded as normal, and the frontal sinus must be examined.

FIG. 129. Anterior rhinoscopy. M, Middle turbinate. I, Inferior turbinate. On the right side (R) pus (white) is seen coming down between the turbinates; on the left side (L), pus comes down above the middle turbinate.

Transillumination may be done here also by pushing a small lamp up into the orbit, but in most instances it will be essential to catheterize the sinus through the infundibulum, and this is seldom possible till the anterior part of the middle turbinate has been cut away, after which a suitably curved catheter is introduced and the cavity washed out. If no pus be found the inflammation must be in the anterior or middle ethmoidal cells, and the orifices of these are enlarged with a hook or ring-knife and their cavities washed out. It not infrequently happens that more than one of the sinuses opening into the middle meatus are infected together, and thus if suppuration of the maxillary antrum be found it does not exclude a similar condition of the ethmoidal or frontal sinus, so that if the first condition does not improve on treatment suppuration of the other sinuses may be suspected. Where pus comes down over the middle turbinate the latter must be removed to afford access to the ostium of the sphenoidal sinus, when the latter may be washed out through a catheter.

SIGNS OF AFFECTIONS OF INDIVIDUAL SINUSES. (1) *The Maxillary Antrum*. This sinus may be infected by a spread from the roots of the teeth which are imbedded in its floor or by spread of a catarrh of the nose (especially if influenzal) ; blocking of the ostium by polypi may be a cause, but the latter are often the result of long-continued suppuration.

Signs. Headaches, dull pain referred to the upper jaw and teeth. In acute cases there may be fever and very severe pain in the jaw, while where the condition is more chronic and the ostium becomes blocked the cavity becomes expanded and presents the characters of a tumour of the upper jaw, viz. blocking of the nose on that side, pushing up of the eye, bulging down
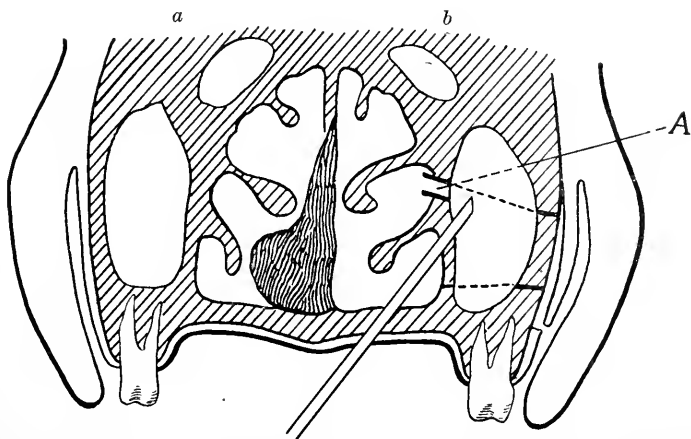
FIG. 130. *a*, On this side is seen a spur of the nasal septum. *b*, Showing how to make exploratory puncture of the antrum of Highmore and the amount of bone removed in performing a radical operation after turning up a flap of the gum. A, Ostium of antrum of Highmore.

of the palate, and thinning of the front of the upper jaw, which may be felt crackling and flexible on palpation from the face. Such cases are exceptional, and the most usual leading sign is escape of pus from one nostril, which is most marked when the patient stoops down. The diagnosis is made by transillumination and diagnostic puncture through the inferior meatus as just described.

Treatment. In acute conditions such as those following influenza, it may be sufficient to wash out the antrum through the diagnostic puncture once, twice or more times, taking care that the middle meatus is patent. Where following on carious teeth these are extracted and the sockets drained, and acute cases of this origin may subside. Where the condition becomes chronic permanent drainage should be established into the nose as follows : The antrum is opened from outside through the mouth, by turning up a flap of mucosa from the upper jaw opposite the first molar-tooth and chiselling into the antrum. Through this opening the polypi and granulations which usually fill the antrum are removed with a sharp spoon ; the inner wall is then removed into the nose, first cutting away the anterior part of the inferior turbinate. The cavity is packed with gauze, which comes out

through the inferior meatus of the nose, and the mucosa of the jaw is sutured back in position so that the antrum is cut off from the mouth. The cavity is packed from the nose for a short time and then simply washed out with astringent lotion till covered with healthy epithelium. Should crusts tend to collect in the cavity the patient will have to keep it clean by daily irrigation.

(2) *The Frontal Sinus.* Suppuration usually follows on that of the nasal fossæ, but may be part of an osteomyelitis of the frontal bone. The condition is usually chronic, with headache on the affected side, tenderness of the forehead, and discharge of pus from the nostril on the affected side.
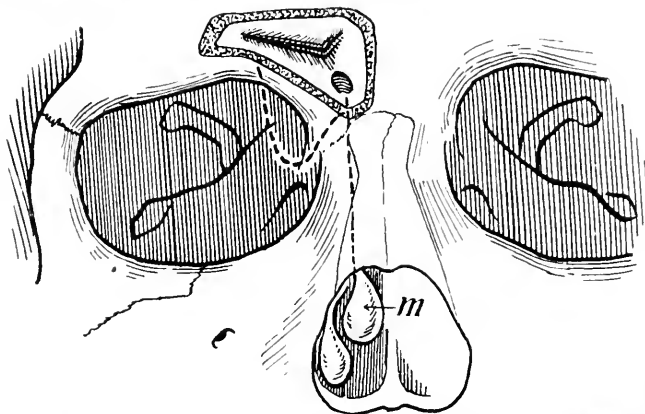
Fig. 131. Diagram of operation for opening right frontal sinus. *m*, Middle turbinate; the dotted line above this indicates the route of the infundibulum. The curved dotted line shows the route to expose the ethmoidal cells.

In ultra-acute cases there may be fever, rigors, delirium with intense pain, tenderness, œdema, and redness over the sinus on the forehead. In more chronic cases the infundibulum may be blocked and the sinus become distended, the wall thinned and bending on palpation; the enlargement encroaches on the orbit, pushing down the eyeball. These extreme types are far less common than the variety where unilateral suppuration and headache are the most notable signs, the diagnosis of which has already been described, by irrigation through the infundibulum with a catheter.

Treatment. (a) In ultra-acute cases with redness and œdema of the forehead there must be no delay, as there is much risk of infection spreading back through the orbital plate, leading to meningitis or cerebral abscess. The sinus is exposed by an incision along the eyebrow and the front wall chiselled away, pus and granulations removed, and the infundibulum enlarged into the nasal cavity, tubes or gauze being inserted down this aperture and out of the nose. When the inflammation subsides the wound in the forehead may be allowed to close, drainage being maintained through the infundibulum; should severe signs persist, it may be necessary to open the roof of the sinus into the anterior fossa of the skull and explore for intracranial complications, which are similar to those following mastoiditis.

(b) In less acute cases where there is fever, intense pain, and tenderness but no œdema, it may suffice to remove the anterior part of the middle turbinate, when drainage through the infundibulum will probably become re-established ; but if symptoms are not relieved in a few hours it will be safer to open the sinus from the forehead as before rather than to run any risk of intracranial complications.

(c) Chronic cases may be cured in their early stages by irrigation through the infundibulum after removing the middle turbinate, but where this fails the sinus should be opened from the forehead.

Operation. An incision is made just above the orbital margin, the inner end curving down on the nasal process of the maxilla. The soft parts are retracted and the sinus opened with a gouge above the supra-orbital margin, and polypi and granulations removed from the sinus. Attention is then directed to the lower part of the sinus, enlarging the opening of the infundibulum into the nose, and as the ethmoidal cells are often affected as well, these should be opened into the frontal sinus, stripping the soft parts from the inner angle of the orbit to secure a good exposure. Drainage is then established into the nose through the enlarged infundibulum, removing the middle turbinate if necessary. The orbital margin is left if possible, and drainage is entirely through the nose.

(3) The *anterior ethmoidal cells* are usually affected together with the frontal or maxillary sinuses, and mischief here is only detected by persistence of suppuration when the latter have been under treatment. In some instances, however, especially in children, the drainage of these cells becomes blocked by chronic inflammation, and they dilate, producing a *mucocœle*, which is found as a painless, fluctuating swelling of the inner wall of the orbit, above the tendo oculi and below the trochlea. Its position, greater depth, and fixity will distinguish from a mucocœle of the lachrymal sac, while the latter can usually be emptied through the canaliculi by pressure, while the ethmoidal mucocœle cannot be thus emptied.

Treatment is by a modification of the operation above described, opening the cells from the inner wall of the orbit, removing granulations, and securing adequate drainage into the middle meatus of the nose after removing the middle turbinate. It is possible in some instances to curette out these cells from inside the nose, but the method is less certain of removing all diseased structures.

(4) *The Sphenoidal Sinus.* In most instances there are headache, dryness of the throat and nasopharynx, and flow of pus from the olfactory fissure coming from above the middle turbinate. Where the outlet of the sinus is blocked by chronic inflammation there may be dilatation of the former and pressure on the optic nerve, causing defects of vision. This sinus is drained by enlarging the ostium after removing the middle turbinate to afford access. The anterior wall is chipped away from around the ostium with hook- or punch-forceps. Care is needed not to injure the posterior wall or meningitis may be caused. When drainage has been established irrigation with astringents is carried out.

(5) *The Posterior Ethmoidal Cells.* Suppuration of these will produce similar signs to that of the sphenoidal sinus, and is distinguished by the appearance of pus in this region shortly after the sphenoidal sinus has been well irrigated. Their opening may be enlarged after removal of the middle turbinate and drainage established.

OTHER AFFECTIONS OF THE ACCESSORY SINUSES. In the maxillary antrum are found polypi, which are of inflammatory origin. The usual new growths are cancer and sarcoma, less often odontomes and fibrous growths, all of which are considered under Affections of the Jaws. In the frontal sinus ivory exostoses are found, which have been mentioned in the section on the Skull (vol. i, p. 577). Malignant tumours have been reported but are very uncommon.

THE NASOPHARYNX. This cavity is the seat of various infections, acute and chronic, associated with similar conditions of the nasal mucosa and the accessory sinuses, but above all with hyperplasia of the lymphoid tissue in the roof of the cavity known as adenoid vegetations.

ADENOIDS (hypertrophy of Luschka's tonsil). Around the entrance of the oro-pharynx is a belt of lymphoid tissue which in the nasopharynx is called Luschka's tonsil, in the fauces the tonsils, and on the posterior part of the tongue the lingual tonsil. The function of this lymphoid tissue is problematical ; it is usually regarded as a defence against microbic invasion, but as it often becomes chronically infected itself and leads to further diffusion of pathogenic organisms, *e.g.* tubercle bacilli, pyogenic cocci, &c., its usefulness does not appear very great, and its removal is seldom other than beneficial. As with lymphoid tissue elsewhere, this collection about the oro-pharynx is more developed in infancy and adolescence, often disappearing in later life ; nevertheless enlargements of this tissue may be found even up to middle age. The cause of hypertrophy of lymphoid tissue in this region is uncertain : as it occurs in healthy individuals it can hardly be due to malnutrition ; chronic mild infection plays some part in its causation but is as much a result as a cause ; mouth-breathing is to some degree a cause but also a result.

Signs. There are two main results of adenoid growths, viz. liability to infections and nasal obstruction. As a consequence of the first, children with adenoids suffer with repeated attacks of coryza (sometimes being hardly ever free), with discharge of mucus and perhaps blood from the nose, while tuberculous glands of the neck and secondary infections of the pharynx are common sequelæ. The block in the nasopharynx causes the patient to hold the mouth open for respiration and to snore at night. The impaired respiration affects the whole nutrition and the attitude is poor ; kyphosis, scoliosis, poked head result. The nasal cavities are not properly distended on respiration and become small, the palate arching up into them and the incisor teeth projecting. The growth round the Eustachian tubes and attacks of infection cause blocking of the latter, leading to deafness and often to otitis media, and inability to catch conversation gives the features a dull, stupid appearance, while mentally these patients are often

sluggish and inert.   Nocturnal enuresis and night terrors are often due to adenoids.

The dull, stupid appearance, open mouth, pinched nostrils, projecting teeth, will at once suggest the diagnosis, and this is verified by examining the nasopharynx with the finger, when soft masses of adenoid material are readily felt, or by inspecting by posterior rhinoscopy.   Adenoids should be suspected and examination made in all cases of deafness, otitis media, spinal deformity, tuberculous glands of the neck, nocturnal enuresis, night terrors, &c., in children, while other causes of nasal obstruction should be excluded at the same time.
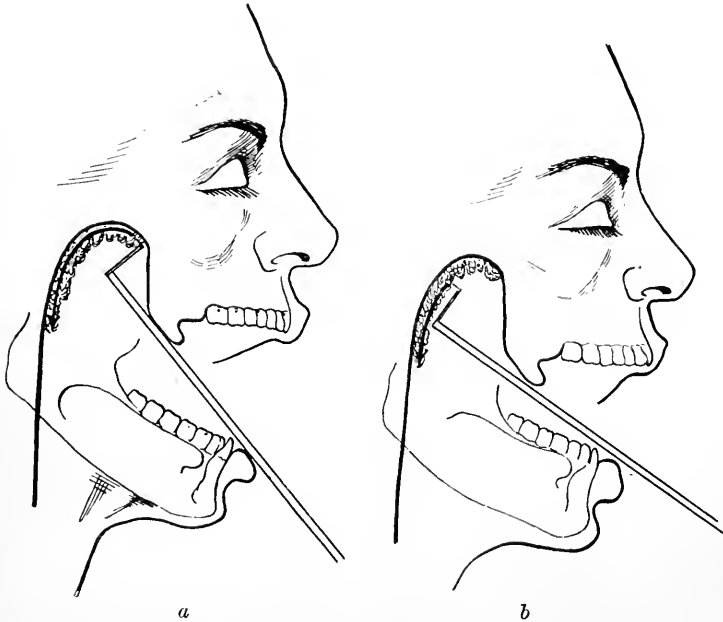
FIG. 132.   Showing correct position of curette to remove adenoids (a).   In (b) those of the roof will escape.

Adenoids are found in quite small infants (three months or less), being an important cause of " snuffles."   Owing to the small size of the nasopharynx examination is difficult, and where the condition is suspected it is as well to sweep a small curette over the roof and posterior wall ; this will remove adenoids if present, while if there are none no harm will result. From nasopharyngeal fibro-sarcoma the greater hardness and roundness of the latter will at once distinguish.

Treatment.   It will thus be seen that the development of adenoids has a wide influence not only on their immediate connexions in the nasopharynx, but on the whole physical and mental development of the child. In the slighter cases preventive measures consist in encouraging breathing through the nose.   This rests with mothers, and the advice in the adage " Shut your mouth and save your life " can be followed early in the child's

existence if the parent will close the infant's mouth while sleeping. Where the patient is of sufficient age to obey instructions, simple breathing exercises performed in slow time, expanding the chest thoroughly and keeping the mouth firmly shut, are preventive and curative not only of the adenoids but also of the thoracic and spinal complications. In most instances, however, by the time advice is sought operative measures and removal of the adenoids will be essential as a first step, breathing exercises being then carried out to complete the cure. In about half the cases enlargement of the tonsils is associated with adenoid growths, and these should be removed at the same time. In the case of infants, a single sweep of a small curette without anæsthesia, suffices. In older children anæsthesia is advisable, the A.C.E. mixture being much safer than ethyl-chloride and giving a more prolonged anæsthesia than nitrous oxide. The child is in the dorsal position and the mouth gagged open, but the head is not extended or the removal will be incomplete. Adenoid curettes are multitudinous in variety ; a good form is that of Delastanche, which has a cage and small hooks at the back to catch the portion removed. The curette is passed behind the soft palate (if not behind, the palate will be severely injured by the process of curetting), pushed up into the nasopharynx, and pulled forward to the nasal septum ; the cutting end is then firmly made to sweep up, back, and finally down, thus shaving the roof and posterior wall of the nasopharynx, removing all adenoid material. The lateral part of the mass is usually removed as well, but a sterile forefinger should be introduced and any adenoid matter remaining round the Eustachian tubes scraped away. Such treatment will generally suffice and not be followed by recurrence, but the vehement scraping advocated by some, as if the nasopharynx were a personal enemy, is to be deprecated as likely to injure the Eustachian tubes and set up infections of the middle ear. The patient is placed face downwards till bleeding ceases, which will usually take place in a few minutes. As regards after-treatment, irrigation is inadvisable : when living in towns dust should be avoided by keeping indoors for a couple of days, but in the country there is no need for this precaution. The throat should be examined after four days, and any tags of adenoid material which are torn down should be removed with forceps. Breathing exercises should be commenced immediately and persevered with until mouth-breathing is abolished. This part of the treatment is quite as important as the operation, and parents should be well informed of this. Where deafness is a prominent symptom the Eustachian tube should be inflated by Pollitzer's method. Where tonsils are to be removed as well it matters little which are taken first, though when the latter are very large it may be hard to reach the adenoids till they have been removed.

New Growths of the Nasopharynx. These are usually fibro-sarcomas, taking origin from the mucoperiosteum of the basi-sphenoid or basi-occipital bones, and are found in young subjects about puberty or in early adult life. They have been described as " fibrous polypi " to distinguish them from the ordinary gelatinous or mucous nasal polypi, but these conditions have

little in common either as regards origin or course, and, except that both may block the nasopharynx, have little resemblance.

The malignancy of these tumours varies, some being little more than rapidly growing fibromas, while others are spindle-celled sarcomas of high malignancy and tendency to form metastases.

Signs. There are nasal obstruction, usually bilateral, snoring, and often deafness ; as the tumour advances the root of the nose may be widened, the speech become nasal, and the palate bulged into the mouth ; discharge of blood and debris occurs where the tumour is ulcerating. Posterior rhino-scopy will show a reddish, rounded tumour occupying the nasopharynx, quite different from the shaggy, soft adenoids or grey, translucent nasal polypi : palpation will show the growth to be firm and rounded, quite unlike the other conditions. Later hæmorrhage may be fatal or in-vasion of the cranium lead to death from intracranial pressure or meningitis.

Treatment. Where the tumour is small, pedunculated, and rather fibrous than sarcomatous it may be snared through the nose and so removed. In most instances, however, the condition will not be noted till too late for this method of attack, and it will be necessary to make a more determined effort for removal if operative measures be attempted at all. Several routes have been employed, but none are completely satisfactory.

Attempts to enlarge the nasal cavity, such as the method of Rouge, where the mask of the face is displaced upwards by cutting through the attachments of the upper lip and nose to the facial bones, from the mouth ; Ollier's, where the nose is turned down by cutting through its root ; Langenbeck's, of detaching it sideways, cutting through the nasal process of the maxilla, may be dismissed as giving little, if any, more room than working through the natural nose after removal of the turbinates. There remain to be considered the palatine route of Nelaton and osteoplastic reflection of the upper jaw.

Nelaton's operation consists in splitting the soft palate in the sagittal direction, dividing the mucoperiosteum of the hard palate in the same line, and stripping this from the bone, which is removed with the chisel, together with the vomer and other parts of the nasal septum. The exposure is only moderate at the best. The incision in the hard and soft palate is closed as in an operation for cleft-palate.

Temporary reflexion of one upper jaw may be performed through a similar incision to that used for its excision, viz. splitting the upper-lip in the middle line, encircling the base and side of the nose, and continuing halfway along the lower margin of the orbit. The alveolar margin, hard palate, nasal process, and attachment to the malar-bone are divided, the soft palate split, and the upper jaw levered outwards. The exposure of the nasal cavities and nasopharynx is about the best obtainable, and in really difficult cases the jaw may be completely removed. The growth is then removed with scissors and chisel as completely as possible, hæmorrhage checked with

gauze-packing, and the jaw swung back into place and retained with a wire through the anterior part. In all these cases it is good practice to perform a preliminary laryngotomy and plug the lower pharynx before commencing the anæsthetic. In some instances apparently inoperable ligature of the external carotid, or this combined with injection of boiling water, will so reduce the size of the tumour that removal becomes possible. Heavy doses of X-rays through an aluminium screen are worth a trial in these cases after as thorough a removal as possible, or in cases where operation seems impracticable.

CHAPTER XXVIII

SURGERY OF THE JAWS AND TEETH

Fractures of the Upper Jaw : Fractures of the Lower Jaw : Dislocation of the
Lower Jaw : Subluxation of the Lower Jaw : Dental Caries and its Results :
Alveolar Abscess : Abnormal Eruption of Teeth : Extraction of Teeth :
Gingivitis : Pyorrhœa Alveolaris : Hypertrophy of the Gums : Periostitis of
the Jaws : Phosphorus Necrosis : Tuberculosis, Syphilis, Actinomycosis :
Tumours of the Jaws : Odontomes : Epulis : Osteoma : Myeloid Sarcoma :
Malignant Tumours : Affections of the Temporo-mandibular Joint : Trismus
and Ankylosis : Operations on the Jaws and Temporo-mandibular Joint.

THESE supports of the mouth, armed with teeth and covered on their intra-
buccal portion with mucoperiosteum, " the gums," differ somewhat in the
affections to which they are subject from the other parts of the mouth,
tongue, cheeks and palate, and hence are considered in a special chapter.
The maxillary antrum, which forms a large part of the upper jaw, is closely
related to the nose, and is discussed for the most part in the last chapter,
while the orbit and lachrymal duct are also affected in certain conditions
of the upper jaw.

INJURIES OF THE JAWS

Fractures of the jaws are fairly common accidents and of varying magni-
tude.   The alveolar margin may be broken off by blows, falls, or in the
extraction of teeth, while the crown of a tooth may be broken from the
root under similar circumstances.   These minor fractures need little treat-
ment : the mouth is kept clean with a mouth-wash of 1 in 100 carbolic, when
healing will readily take place.   When teeth are knocked out an attempt
may be made to replace them, which sometimes will be successful, otherwise
the socket is packed with sterile gauze, changed daily for three days to
prevent access of infection to the deeper parts.   Where a crown is broken
off, a dentist can usually fit on an artificial crown, after removing the pulp.

FRACTURES OF THE UPPER JAW.   These are usually of the minor variety
mentioned above, but severe injuries may produce more complete fractures.
The antrum may be broken open or the lower part of the jaw, including
the hard palate and alveolar margin, broken away, or the articulation with
the malar-bone may be broken through.

From gunshot or shell wounds both upper jaws may be broken off the
rest of the skull, and we have seen this result from the bursting of a grind-
stone revolving at very high speed.   Such fractures are usually compound
and easily recognized by the mobility of the fragments, crepitus, and altered
alignment of the teeth.

Treatment. As displacement is usually slight, nothing but an antiseptic mouth-wash may be needed ; displacement should be corrected, and if tending to recur, prevented by fixing the jaws together with a four-tailed bandage, thus using the lower jaw as a splint.

FRACTURES OF THE LOWER JAW. Complete fractures of this bone are more common and due to indirect violence, the rami being forced together by crushing or a severe blow on the side of the jaw. The jaw gives way most commonly at its weakest point, close to one of the canine teeth. Less often the fracture is at the symphysis or angle, sometimes the coronoid process or condyle is broken off.
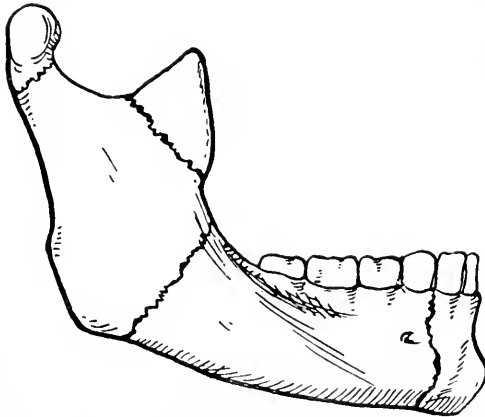
FIG. 133. Position where fractures of the lower jaw are prone to occur.

Fractures at the seat of election are practically always compound and are occasionally bilateral. The displacement is as follows : the larger fragment remains stationary, the smaller being displaced out and forward by the masseter. Where the fracture is bilateral the central portion is depressed by the hyoid muscles. Fractures at the angle or through the coronoid show little displacement. Where the condyle is broken off the jaw is pulled across to the injured side by the unopposed action of the opposite external pterygoid (in dislocation the displacement is in the opposite direction).

Diagnosis. Loss of alignment of the teeth and lower border of the jaw, together with crepitus, will be found in fractures through the canine fossa ;
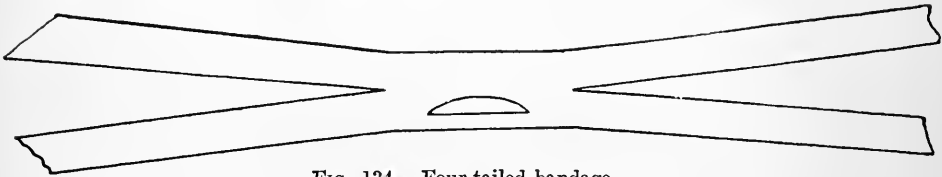
FIG. 134. Four-tailed bandage.

crepitus and swelling where the fracture is at the angle ; and crepitus, swelling, and displacement when through the neck of the condyle.

Treatment. In most instances, after reducing the displacement the fragments can be kept in position by fixing the lower jaw to the upper (the mouth being shut) with a four-tailed bandage for three weeks, during which time liquid nourishment will be needed. Where skilled dental assistance is obtainable it is better to fit a horse-shoe-shaped splint over the teeth of the lower jaw and fix with dental cement till union is good, as with this appliance the patient can very soon eat normally. It is necessary for this plan to

take a cast of the teeth on either side and make a splint to fit accurately (Fig. 135). Where the assistance of a dentist is not forthcoming and the deformity is bad the fragments should be reduced and fixed with a wire or plate through an incision along the lower border of the jaw, stripping off the soft parts till the bone is well exposed. The mouth must be kept clean as infection is likely to take place, and should this occur, abscesses will require opening below the jaw and union is delayed but takes place ultimately, non-union being very uncommon here.

Fig. 134A. Four-tailed bandage applied for fractures of the lower jaw.

Where the fracture is at the angle or through the neck of the condyle the fracture will not be compound, and union takes place if the jaw be kept fixed with the four-tailed bandage.

DISLOCATION OF THE LOWER JAW. This is always forward, except in rare cases where the condyle is driven back by great violence, fracturing the tympanic plate of the auditory meatus and perhaps the base of the skull. This dislocation takes place from opening the mouth too widely, as in yawning, taking a large bite, in depressing the tongue, extracting a tooth, or opening the mouth with a gag.

In the normal action of opening the mouth the condyle slides forward on the eminentia articularis, and, if the movement be excessive, may slip over the latter and remain locked by spasm of the temporal and masseter muscles. Dislocation may be unilateral or bilateral.

The deformity in bilateral dislocation is characteristic. Saliva drools from the widely open mouth, while speech is inarticulate, the patient pointing helplessly to the mouth. A hollow is noted immediately in front of the tragus owing to the absence of the condyle, while in front of this is an elevation due to the presence of the condyle.
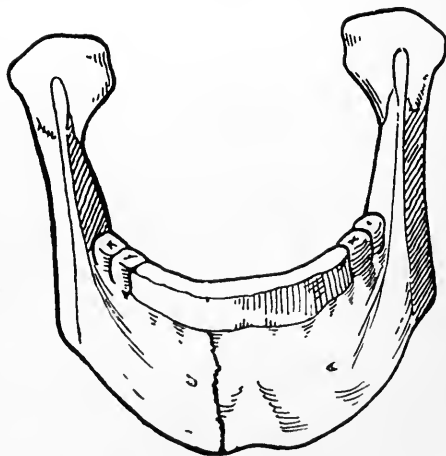
Fig. 135. Dental splint for fractured lower jaw.

In a unilateral case the deformity is similar but less marked on the affected side, while the chin is displaced to the sound side.

Treatment. Reduction is accomplished by placing the patient, seated on the floor or a low stool, with the back and occiput against the wall. The operator's thumbs are bandaged to prevent their being bitten by the incisors when the jaw snaps back. The thumbs inside the mouth depress the back of the jaw at the last molar tooth, while the fingers grasp the lower margin of the jaw. By depressing the back of the jaw and pulling the front up, the condyle can be made to slip over the eminentia articularis and the jaw snaps back : in muscular subjects reduction of the jaw may require no mean effort on the part of the surgeon : in difficult cases anæsthesia will be needed.
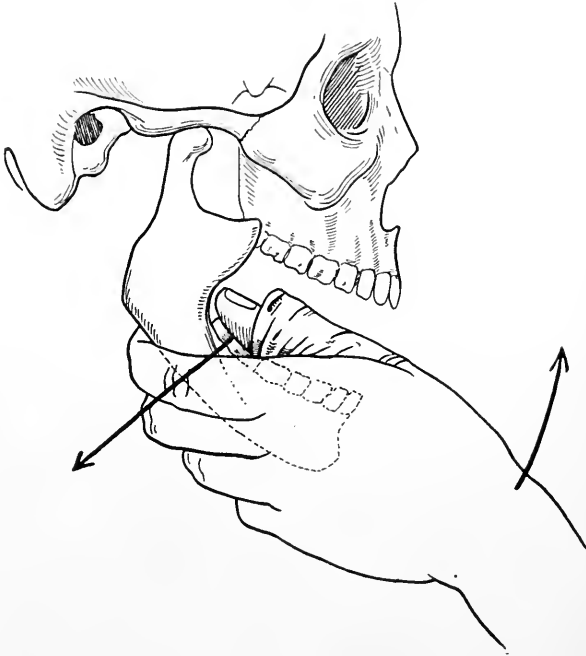
Fig. 136. Method of reducing a dislocated mandible. Note the guarded thumb.

In old-standing cases reduction may be impossible, and if it fails after several good trials the condyle of the jaw should be excised to improve the movement of the jaw (p. 410).

SUBLUXATION, OR INTERNAL DERANGEMENT OF THE JAW. In this affection the interarticular cartilage is loose or displaced, causing a check in the movement of the jaw in opening or closing, and sometimes pain and an unpleasant snapping ; it especially affects young females. Tonic treatment and counter-irritants will often cure, but if the condition persists the joint is exposed by a horizontal incision and the cartilage remove

THE TEETH

The prevention and cure of dental disease form at present one of the most satisfactory branches of conservative medicine, demanding but little notice in a work on surgery, and the practitioner will do well as far as possible

to consult dentists in cases of this nature.   Still a knowledge of the correct
method of extracting teeth is needful in some purely surgical operations
such as removal of the jaw, as well as in neglected cases of dental caries
and periodontitis, where no dental service is forthcoming.

DENTAL CARIES AND ITS RESULTS.   Caries of the teeth is a slow, infective
disintegration spreading in from the enamel to the pulp cavity.   When the
latter is exposed the tooth becomes exquisitely sensitive to heat and cold ;
later the pulp becomes inflamed and there is a constant stabbing pain in
the tooth, till the pulp necroses and dies, which may take some time ; next
the infection can spread down the fang and pass out of the apex of the root
into the tissues about the latter, setting up periodontitis and alveolar abscess.
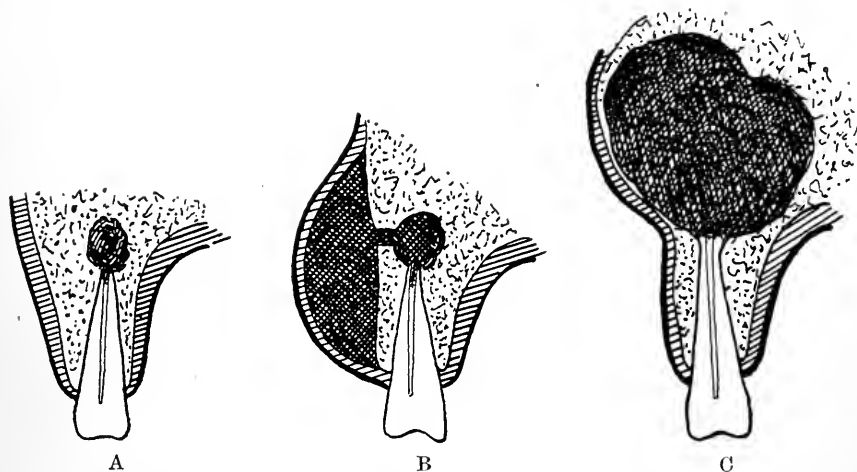
FIG. 137.   A, Small abscess about the root of a tooth.   B, Dental abscess which
has perforated the alveolus and spreads under the gum as an alveolar abscess.
C, Chronic dental abscess or " dental cyst," expanding and rarefying the surround-
ing jaw.

From the apex of the fang the infection may spread quietly through the
alveolus by a process of rarefaction and so reach the under surface of the
gum, the resulting swelling or subacute abscess being known as a " gum-
boil," which if opened or burst becomes a dental fistula.   In other instances
the infection spreads up along the socket of the tooth, loosening the latter,
and becomes superficial round its neck.   In other cases the infection is
more severe and widespread, so that a large collection of pus is formed,
stripping the periosteum and leading to necrosis of the jaw : such an
" alveolar abscess " is a magnified condition of gumboil.   In yet other cases
the infection is chronic and remains localized around the root of the tooth,
the pus being retained in a sac which by its expansion causes atrophy and
thinning of the superjacent bone, which becomes expanded ; such a chronic
abscess is known as a " dental cyst."   When small, such cysts may be
removed on extraction of a tooth sticking to the apex of the root.

Treatment.   There is great scope for conservative dentistry in these
cases.   Caries may be kept in check by early " fillings " : infected pulps

can be killed and extracted, the cavity rendered aseptic, and the tooth stopped. Even where the less severe forms of alveolar abscess are present it may be possible to preserve the tooth, draining the abscess inside the mouth, cleaning the inside of the tooth with repeated dressings and eventually filling the latter. Where, however, dental treatment is not obtainable, or in the large ultra-acute abscess found in neglected cases, it will be necessary to extract the carious tooth and open the abscess freely. This should be done from inside the mouth if possible, but where there is already much periostitis and the skin is adherent to the abscess it may be done from outside, especially in the case of the lower jaw.

The amount of the resulting necrosis varies greatly ; a large surface of the jaw may be denuded of periosteum by an alveolar abscess and yet not necrose, but in less fortunate instances large sequestra form and slowly separate.

Complications are : trismus from inflammation of the masseter, usually where the affection is of the lower molars ; involvement of the maxillary antrum, when the bicuspids or molar of the upper jaw are involved.

Severe glandular infection or cellulitis of the neck may result in neglected instances, and occasionally fatal septicæmia.

ABNORMAL ERUPTION OF TEETH. The only example likely to come under surgical treatment is where a wisdom-tooth does not erupt properly, presumably owing to the jaw being too small. The result is severe toothache and often spasmodic closure of the jaw (trismus) from spasm of the masseter. The condition is to be suspected when trismus and toothache occur in young adults with unerupted wisdom teeth, and a skiagram will show the wisdom-tooth in some faulty position, perhaps jammed horizontally against the second molar.

Treatment. Under anæsthesia the jaw is opened with a gag and the second molar removed, when the impacted wisdom tooth will erupt in its place, or if not is removed later with the elevator.

EXTRACTION OF TEETH. This is in most cases an easy matter if the operator bears in mind a few simple rules, which may be learned by a few days' practical experience in the extraction department of a dental school. It should be clearly recognized that the different shapes of forceps fit them for different work. Thus upper molar forceps differ on the right and left sides, to fit the two outer and one inner roots of these teeth. Teeth with one root are attacked with hollow-bladed forceps. Forceps for the upper teeth have the blade and handles practically in one line, while for lower teeth the blades are at right angles to the handles. In extracting it is important to stand in the right position, viz. in front for left lower, on the patient's right for upper teeth, behind for right lower teeth, protecting and steadying the jaw with the fingers or finger and thumb of the left hand.

Finally, it should be noted that pulling is the movement least used in making an extraction. Rotation and boring are used for incisors and bicuspids ; rocking laterally for molars. The final extraction is outward from the mouth in most instances, but in the case of the posterior molars

rocking inward is often useful or even backward for wisdom teeth. A sensitive hand on the forceps will detect the path of least resistance and cause the tooth to move in the most suitable direction. Great force is seldom needed, but judicious pushing in the right direction. Above all, the forceps should be forced well home so as to grip the neck or some deeper and more solid part of the tooth, lest the crown be broken off. Extraction of buried stumps or impacted wisdom-teeth may be very difficult and the elevator be necessary, or possibly in the latter case a chisel. It need hardly be said that extraction of teeth should be conducted with full aseptic precautions, the instruments being boiled and the resulting cavity lightly packed with sterile gauze for a couple of days, while an antiseptic mouth-wash is prescribed.

As regards complications of extraction, fracture of the jaw has been described, and may be unavoidable in certain cases. Another trouble is persistent hæmorrhage from a tooth-socket ; where this does not yield to lavage with hot water the socket is packed firmly with gauze soaked in adrenalin. Where the patient is hæmophilic, hæmostasis may be very difficult, and it may be fair to crush the alveolar margin with strong forceps.

AFFECTIONS OF THE GUMS

Gingivitis, or inflammation of the gums, is common in chronic mercurialism, scurvy, and other forms of stomatitis, or may be due to local conditions such as carious teeth, or the condition next described (pyorrhœa).

The gums are soft, tender, spongy, and bleed readily ; the teeth become loose and drop out.

Treatment. The general condition of scurvy or mercurialism is treated : locally the teeth are put in order and antiseptic mouth-washes employed and frequent but gentle cleaning of the teeth ; the gums may be painted with silver nitrate 5 to 10 per cent., and pockets around the teeth irrigated with hydrogen peroxide.

Pyorrhœa Alveolaris (Rigg's disease). This is a chronic form of gingivitis in which there is suppuration with ulceration of the gums next the teeth ; the former retract, exposing the root of the latter, which become carious and drop out owing to rarefaction of the bone of the alveolar margin. This condition is often associated with want of oral cleanliness and accumulation of tartar, but may also occur in mouths otherwise clean. The condition is recognized by stroking the gums towards their edge, when pus will be squeezed out at the margin next the tooth. The condition varies in extent and virulence. The prognosis of this affection is, on the whole, not good. Early cases in otherwise healthy persons may be cured, or at least palliated to such a degree that the teeth may be preserved for many years, while in cases of longer standing or in less healthy individuals the condition persists in spite of treatment till the teeth drop out or are extracted. The affection forms part of the condition known loosely as " oral sepsis " ; the pockets of pus under the gums form a source of infection for the lower respiratory and gastro-intestinal tracts and may set up a systemic

poisoning, greatly lowering the general health, or may be the original fount
of such conditions as periostitis, arthritis, empyema, &c., while also acting
as a possible source of infection if the patient is to undergo operation on
the pharynx, larynx, stomach, &c. In cases where operation in these
regions is contemplated the safest plan is to remove all the affected teeth
several days before operation.

Treatment consists for the milder cases in oral antisepsis, removing tartar,
stopping or extracting carious teeth, while the pockets around the teeth
under the gums are swabbed or syringed out with hydrogen peroxide :
mouth-washes of antiseptic lotion and brushing the teeth are carefully and
frequently employed. Granulations are cut away or painted with solution
of silver nitrate. Vaccines are well spoken of by some, but it is doubtful
if they are of more than transient service.

In the more severe condition, as met with in hospital practice, extraction
of all the teeth and providing artificial dentures will most speedily cure the
condition and improve the patient's general health.

Hypertrophy or *polypus* of the gums is an allied condition to the above,
but is local and often without suppuration, occurring round a carious tooth
as a reddish polypoid growth, which is to be distinguished from the fibro-
sarcoma or pink epulis of the gum. The condition is cured by removal of
the carious tooth, cutting away and cauterizing the polypoid mass.

INFECTIVE DISEASE OF THE JAWS (PERIOSTITIS, ETC.)

The larger number of cases of osteitis of the jaw originate in dental
caries and infection ; this applies equally to acute conditions, as alveolar
abscess, or chronic affections, such as actinomycosis or phosphorus
necrosis.

(1) Acute osteitis or necrosis of the jaw, except in the form of alveolar
abscess, is not common, but occurs from fractures of the body of the jaw,
in mercurial or phosphorus poisoning, or as a sequel to exanthemata,
especially scarlet fever and measles, when it is part of the severe gangrenous
condition known as cancrum oris. Acute osteomyelitis of blood-borne
origin sometimes attacks the upper jaw in small children.

Signs. High fever, possibly rigors, and locally a tender, brawny swelling
along the jaw, inside and outside the mouth. The brawny swelling softens
and bursts, leaving a large area of bone denuded of periosteum, and later
a sequestrum of varying size separates.

Treatment. The brawny swelling should be incised freely at its softest
part, for choice inside the mouth, but when affecting the angle or body of
the lower jaw and sometimes in the upper jaw, it will be necessary to open
through the face or neck. Drainage should be efficient and the wound
irrigated with peroxide of hydrogen. As mentioned, some cases where there
is much bare bone heal without any sequestrum separating, but in others
a large sequestrum comes away, taking months to separate, which
should be removed if possible from inside the mouth, but if very extensive
by an incision below the jaw.

(2) PHOSPHORUS NECROSIS. This affection is seldom seen since the adoption of red phosphorus for match-making and the greater precautions adopted in factories; it occurs in persons possessing carious teeth from infection with pyogenic organisms which invade the pulp and periodontal tissues, leading to subacute necrosis of the jaw. This is not directly due to the fumes of the phosphorus, as was formerly thought, but because the lowering of the general vitality by the poison renders the tissues more susceptible to attacks of pathogenic organisms. The process is essentially subacute; the upper jaw is often affected with a brawny swelling which slowly breaks down, and sinuses form; the sequestra are light and porous, in distinction to those of ordinary necrosis, which are dense and hard.

Treatment. Prophylactic measures consist, in using red phosphorus whenever possible, in supervision of the cleanliness of workers in phosphorus (washing before meals, &c.), removal of, or stopping carious teeth. When necrosis is definitely present it is treated by opening, draining, and irrigating abscesses, removing sequestra, &c.

(3) *Tuberculosis* of the upper jaw occurs in children at the junction of this with the malar-bone. Swelling of the face and the formation of a cold abscess result, which needs much scraping before healing takes place.

(4) *Syphilis* seldom attacks the lower jaw, though the hard palate is a frequent situation for gummata, which are responsible for most acquired perforations of the latter. Gummata also occur in the masseter and periosteum under it, leading to a tumour with trismus, resembling in appearance a sarcoma, but readily yielding to specific remedies.

(5) *Actinomycotic* infection occurs in the lower jaw usually about the angle, probably from infection through a carious tooth. The affection commences as a brawny, comparatively painless swelling which involves as well the neck in this region. Later the skin breaks down with the formation of several sinuses, from which the characteristic yellow granules are discharged and which lead down to carious and necrotic bone.

Diagnosis is made by microscopic examination of the discharge, as conditions very similar clinically arise from subacute pyogenic infections or the breaking-down of cancers.

Treatment. The necrotic tissue is removed freely by scraping and excision, while iodides are given internally. In this way many cases are cured.

TUMOURS OF THE JAWS

A variety of new growths originate from the jaws and show a certain selection as to the part of the jaw from which they spring. Thus odontomes generally grow in the lower jaw; from the alveolar margin fibro- and myeloid sarcomas (epulis) usually originate; while tumours of the upper jaw start in the alveolar margin or antrum, the enlargement of which produces characteristic signs, to which allusion has been made in the last chapter.

(1) TUMOURS ARISING FROM THE TEETH; ODONTOMES. Errors in development arising at different stages in the growth of the teeth leads to formation of various tumours (Bland Sutton).

(a) When the departure from normal development takes place at an early stage while the enamel organ (which consists of columnar epithelium) is still present, there results a mass of spaces lined with columnar cells set in a matrix of bone and connective tissue ; this is the usual explanation of " fibrocystic disease " of the jaw, and it is rendered probable because some of the teeth are missing.

(b) Later, when the crown of the tooth is developed and is enveloped in a fibrous tunic or " follicle," the development of the root may cease and the follicle become filled with fluid. The tooth is not erupted and remains deep in the jaw, forming a " dentigerous cyst " or " follicular odontome."

(c) After the tooth is fully developed and erupted cysts develop in connexion with the root in consequence of caries and of the tooth. It is stated by French observers that the cystic swellings are formed from relics of the enamel organ, left behind in the process of development, but in many instances such cysts are simply chronic abscesses or " dental cysts." Less common are :

(d) Outgrowths of bone (or exostoses), from the root (radicular odontomes).

(e) Compound odontomes, formed of all the elements of several teeth combined together and forming an ivory-like tumour.

(a) *Fibro-cystic Disease ; Epithelial Odontomes.* These tumours occur usually in the body of the lower jaw in young persons ; growing slowly, they are hard at first, but later, as the expanded bone over them becomes thin, the sensation of " egg-shell crackling " or " horn-bending " is noted. The teeth involved in the tumour will be absent unless the primary teeth maintain their position.

Diagnosis is to be made from myeloid and sarcomatous tumours. The length of history will usually assist in doing this, and exploration will show the cystic nature of the tumour. The possibility of such a tumour being present must always be considered before excising the whole jaw for suspected sarcoma.

Treatment. Local excision, preserving the lower margin of the jaw if possible.

(b) *Dentigerous Cysts ; or Follicular Odontomes.* These consist of an unerupted tooth (often with ill-developed root) lying in its fibrous follicle, which is distended with fluid. (Where the follicle is not distended but simply thickened the condition is known as a *fibrous odontome*, and is found in animals but rarely, if ever, in the human species.)

Signs. The condition occurs in young persons, usually in the lower jaw, as a local swelling, hard at first but later admitting of indentation. The tooth is missing from the alveolar margin, and a radiograph will show the tooth or its crown in the cyst. As in the former condition, the history, the absent tooth, and a radiograph will settle the diagnosis from sarcoma (Fig. 138).

Treatment. The sac is opened from inside the mouth, the tooth or crown removed, the cyst curetted, packed with gauze, and allowed to granulate.

In both these cystic conditions care is needed not to mistake them for sarcoma, since a local operation only is needed for this condition, while for sarcoma wide removal is essential.

(c) *Dental cysts* have already been mentioned under Teeth (p. 408), and it has been mentioned that they are a variety of chronic abscess. The smaller sort are only discovered on extracting a carious teeth, when they may be found adherent to the apex of the root. The larger cysts form slowly increasing swellings, usually of the upper jaw, in connexion with carious teeth or stumps. They may be large enough to cause considerable swelling of the face or even invade the antrum. The bone around is rarefied and expanded so that crackling or fluctuation of the surface of the tumour is felt, which bulges usually on the face but may depress the palate. The contents is a glairy, turbid fluid, often containing much crystalline cholesterine.

Fig. 138. Follicular odontome in a boy of 14. In this skiagram an unerupted canine tooth is seen lying high in the upper jaw and surrounded by a cyst.

Diagnosis. The occurrence of such a bone - expanding tumour in a middle-aged person, situated in the upper jaw and connected with carious teeth, will readily distinguish both from follicular odontomes and solid tumours.

Treatment. The cavity is freely opened from the mouth, the inside scraped out, packed with gauze and allowed to granulate, carious teeth being extracted; where invading the antrum it may be well to establish drainage into the nose and allow the oral wound to close.

(2) TUMOURS OF THE ALVEOLAR PROCESS; EPULIS. These occur in two varieties—the pink or fibro-sarcomatous, the purple or myeloid.

(a) *The Pink, or Fibroid Epulis.* Apparently growing from the gum (whence the term epulis) but really from the periodontal tissues of the alveolus, these tumours appear in young persons, and are firm, smooth,

pink, painless, and not ulcerated. They are to be distinguished from granulation-polypi of the gum starting around carious teeth, and epithelioma of the gum — the former being soft, friable, easily bleeding, the latter sessile, hard, ulcerated and bleeding, while from both comes a purulent discharge which is not present with epulis.

The pink epulis recur if only sniped off, but show no tendency to form metastases, *i.e.* the malignancy is local.

Treatment. Extraction of the tooth on either side of the growth and excision of the latter, with the part of the alveolus between the extracted teeth, from which it springs.

(b) *The Purple, or Myeloid Epulis.* This forms a swelling of more sessile nature than the above and of purple colour; starting more deeply in the alveolus, it may cause loosening of teeth over it as it increases in size. Microscopic examination shows it to be a myeloid sarcoma. Removal on the same lines as for the last condition will prevent recurrence. In rare instances the pink, fibroid

Fig. 139. Myeloid sarcoma of the upper jaw; the clear rarefied area in the front of the maxilla is well seen (skiagram).

variety will be of more malignant and infiltrating type, and although indistinguishable on examination, yet on attempting to remove the growth it will be found widely infiltrating the jaw. In such instances removal of the upper jaw or half the lower will be needed to give a reasonable prospect of cure.

(3) TUMOURS OF THE BODY OF THE JAWS. Innocent tumours are uncommon.

(a) Osteomas sometimes grow from the upper jaw and are of dense structure; they bulge the cheeks forward and are usually bilateral, the condition being known as *leontiasis ossea.* They are distinguished from malignant growths by their hardness, slow growth, and absence of involvement of the palate or orbit.

Treatment. These tumours can be removed with chisel and saw after turning back a flap of the face, as for excision of the upper jaw.

(b) *Myeloid Sarcomas of the Body of the Jaw.* These are found in young persons, usually in the lower jaw, and are slow-growing, causing distension of the bone, which may be local or involve both sides of the body. When invading the alveolar margin the purple colour is obvious, and later eggshell-crackling can be detected.

Diagnosis. From dentigerous cysts the fact that the permanent teeth are in place and if radiograms be made no teeth are inside the tumour will distinguish; from periosteal sarcoma the slower growth and endosteal nature of the tumour distinguishes.

In difficult cases exploratory incision is made, and the maroon colour of the myeloid will at once distinguish from the greyish colour of sarcoma.

Treatment. The growth should be freely exposed by incision inside the mouth and all the tumour removed with curette and gouge, the cavity being treated with cautery or pure carbolic. In most instances such treatment will prevent recurrence, but should this happen a wider excision will be needed. It will, however, generally be possible to spare the dense lower margin of the jaw and thus allow the fitting of a denture.

(c) *Malignant Tumour of the Jaws.* Carcinoma (usually squamous-celled) may originate in the gum, antrum or nasal cavities, and thus reach the maxilla, while round- or spindle-celled sarcomas may take origin in the periosteum of either jaw or the antrum.

(1) In the maxilla the signs will vary with the place of origin. Thus a sarcoma of the facial part will form a hard, rapidly growing tumour in this situation, while if taking origin in the alveolar margin it will resemble a fibrous epulis but grow more rapidly and infiltrate the jaw, causing enlargement of the latter. When starting in the antrum, whether cancer or sarcoma, the signs will be those of expansion of the maxilla, viz. bulging out of the cheek, downward of the palate, upwards of the eyeball, inwards causing blocking of the nostril on that side and epiphora, while if it spread back to the pterygo-maxillary fossa proptosis may result. Expansion may take place in some or all of these directions.

Diagnosis is made on the rapidity of the enlargement of the maxilla: transillumination will show opacity of the antrum (where this is involved), and yet diagnostic puncture produces no pus but only blood. In doubtful instances the antrum may be opened from the mouth and a portion of the contents removed and examined microscopically in frozen section. Should the condition be malignant, excision of the jaw is carried out at once if the condition seems removable (*i.e.* if still confined to the maxilla), for operation is of little use where the tumour has begun to infiltrate behind the jaw or on to the face.

Treatment. Removal of the maxilla when the growth is confined to this. In cases where this is no longer possible, especially in sarcomas, ligature of the external carotid after injecting boiling water, and heavy doses of X-rays, are worth a trial, and will often cause temporary improvement.

(2) In the lower jaw round- and spindle-celled periosteal sarcomas are found; the growth is rapid and uneven, while invasion of surrounding tissues soon occurs—these points readily distinguishing from myeloid sarcoma. More common is squamous-celled cancer spreading from the lips, tongue, gums, floor of the mouth, and tonsil.

Treatment. Removal of half the jaw with surrounding tissues wide of

Fig. 140. A, Sarcoma of the upper jaw, compressing the orbit and bulging the cheek. B, Temporary recession of growth after tying external carotid artery and heavy doses of X-rays.

the infiltrated portion and thorough clearing of the glands of the neck down to the clavicle.

AFFECTIONS OF THE TEMPORO-MANDIBULAR JOINT. *Infections.* (a) The milder infections due to rheumatism and gonorrhœa, &c., cause pain and swelling in the articulation, difficulty in opening the jaw. Usually the condition subsides with restoration of movement, but ankylosis may occur.

(b) More severe and suppurative arthritis may follow the exanthemata, gonorrhœa, pyæmia, or be the result of local spread from suppurative otitis media. The signs are similar to the former condition but more severe: abscesses forming about the joint will burst on the cheek or track along the Glasserian fissure into the ear; disorganization and ankylosis of the joint usually result.

Treatment. Fomentations to relieve pain in the early stages; later abscesses are opened, and if the condyle is carious it is removed, as this will in any case be necessary later to obviate the ankylosis.

(*c*) Osteo-arthritis is not uncommon, the joint undergoing the usual changes—enlargement of the condyle, erosion of cartilage, &c. There are increasing stiffness, pain and grating in the joint, especially in damp weather.

Counter-irritants, tonics, and iodides will relieve in the early stages, but where the action of the joint is much impaired excision of the condyle will greatly improve matters.

(*d*) Tuberculosis may arise primarily or spread from the temporal bone and middle ear; the tendency is to ankylosis. Excision of the condyle is indicated where the disease is advanced beyond hope of resolution.

CLOSURE OF THE JAW; TRISMUS; ANKYLOSIS. Trismus implies spasmodic closure of the jaw from contraction of the muscles of mastication, especially the masseter, and may be due to general or local causes. Of the former, infection with tetanus is the most notable, but hysterical spasm of the jaw is also described. Local causes are many, *e.g.* irritation of carious molars, impacted wisdom-teeth, inflammations or growths of the parotid, tonsils and cervical glands, gumma or growth of the masseter. Such temporary, spasmodic fixation will cease when the underlying cause is treated and cured, if this be possible.

Ankylosis, or permanent fixity of the temporo-mandibular joint, may be due to affections of the joint (intrinsic) or outside it (extrinsic).

Intrinsic Ankylosis. Causes thus affecting the joint are unreduced dislocations, fractures about the condyle, the results of infections, and degenerations of the joint (suppurative arthritis, osteo-arthritis, tuberculosis, &c.).

Entrinsic causes are fibrous bands connecting the mandible firmly with the skull and resulting from the healing of ulceration in and about the mouth, such as burns, cancrum oris, lupus, while ossifying myositis accounts for some cases.

Either form of ankylosis will lead to inability to masticate or take any food unless very soft; speech is impaired, and when the condition takes place in childhood the lower jaw is imperfectly developed, so that the chin is receding and the teeth do not articulate with those of the upper jaw.

Treatment. Where the condition is intrinsic, affecting the joint and condyle only, the latter should be excised. Such measures are useless where the affection is extrinsic, and except in milder cases, where the fibrous bands can be stretched by repeatedly opening the mouth with a gag, a wedge-shaped piece of jaw should be excised at the angle or front of this if the cicatrix extends far forwards.

OPERATIONS ON THE JAWS

Preliminaries. In minor operations, such as removing part of the alveolus for epulis, it will suffice to turn the head to one side and prevent escape of blood into the larynx by sponging and light anæsthesia; but for

major attacks, where the whole or a large part of the jaw is to be removed, a preliminary laryngotomy is always advisable and the lower pharynx is plugged to prevent flooding of the lungs with blood, the anæsthetic being given through the laryngotomy tube (*see* p. 474, Laryngotomy).

(1) REMOVAL OF THE ALVEOLAR MARGIN OF PART OF THE JAW.   This can usually be done from inside the mouth, incising the gum at the site of bone-section and cutting through the latter with a chisel ; where the growth is at the posterior part of the upper or lower jaw the cheek may be split from the mouth to ensure adequate exposure.

(2) Partial resection of the whole breadth of the jaw is only needed in the lower jaw, and then usually as part of an operation for growths of tongue, tonsil, lip, &c., where the jaw is invaded.   In these cases the jaw will be reached through the incision in the neck after clearing the submaxillary triangle and perhaps tying the external carotid artery.   The jaw is sawn through well in front and behind the growth, if possible the lower margin preserved, but if this is not possible the fragments should be secured together in the natural position by a metal bar ending in perforated flanges, which are secured to the fragments with wire or screws.   Later a denture is fitted to the jaw to bridge the gap.

(3) REMOVAL OF ONE WHOLE UPPER JAW.   This operation is indicated for malignant disease, still confined to the jaw.   Care is needed that the tumour really is a new growth and not distension from suppurative disease, odontomes, &c., and exploration should always be made if there is any doubt.

The neck should be attacked first and the carotid and submaxillary triangles thoroughly cleared of glands.   As the carotid is well exposed by this step, it is as well to tie the external carotid above the superior thyroid branch.   Having removed the glands and tied the carotid, the wound is closed and laryngotomy performed, the pharynx plugged and anæsthesia continued through the laryngotomy tube.

The head is brought into the middle line and an incision made, splitting the upper lip in the mid-line, running round the lower and outer sides of the nose to the inner angle of the orbit, and then along the lower margin of the orbit. . The flap of face thus marked out is dissected from the bone upward and outward, the cartilages of the nose separated from the nasal process of the maxilla, and the periosteum raised from the floor of the orbit.   Carefully retracting the eyeball with a broad retractor, the nasal process of the maxilla is divided at the lower inner corner of the orbit, and the attachment to the malar-bone is then divided into the spheno-maxillary fossa.   These divisions are commenced with the saw and finished with bone-forceps, the nasal process being cut by placing one blade of the forceps into the nasal fossa, the other into the orbit   The mouth is then gagged open, the central incisor extracted, and the mucoperiosteum of the hard palate divided in the middle line ; the posterior end of this incision turns out and divides the soft from the hard palate.   The hard palate is then sawn partly through in the middle line from the nasal cavity and the section finished with bone-

forceps. The jaw is thus separated from its bony connections and is levered out with the forceps, then caught with lion-forceps, rotated outwards, and the remaining soft parts about the palate and pterygo-maxillary regions divided with scissors. Bleeding-points are caught and tied and the cavity packed with gauze, first looking for any extensions of growth in the pterygo-maxillary fossa, which must be removed. The facial flap is sutured in position, and if bleeding has ceased the pharyngeal plug and laryngotomy tube removed. The gauze plug remains *in situ* for twenty-four hours, after which the cavity is kept clean by irri-gation till healed (weak carbolic and peroxide lotion alternately are good for this purpose). When healed the loss of the hard palate may be obviated by an obturator. Dropping of the eyeball does not follow re-moval of the orbital plate, but will happen if the suspensory ligament of Lockwood, *i.e.* attachment of Tenon's capsule to the sides of the orbit, be damaged, and as, unless the orbital plate be removed, re-currence is very likely, this should always be done. Œdema of the lower lid is common from cutting through its lymphatics, and hence the lid should be only divided in half its length if possible. In more exten-sive cases the orbit may be cleared

FIG. 141. Incisions for excision of upper and lower jaw and tempero-mandibular joint.

out and the malar-bone removed by dividing its attachments to the external angular process of the frontal bone and to the zygoma.

(4) REMOVAL OF HALF THE LOWER JAW. The operation is indicated for periosteal sarcoma and some cases of epithelioma spreading from the tongue or gums. After preliminary laryngotomy and packing the pharynx, the head is turned to the opposite side and an incision is made, splitting the lower lip in the middle line with the exception of the coloured margin, and raising a flap from the submaxillary region the apex of which is at the hyoid bone, the base extending between the above-mentioned place on the lip and the tip of the mastoid.

If glandular infection is marked a second incision is made from the middle of this along the anterior edge of the sternomastoid muscle to clear the carotid glands. The flap described is turned up and the submaxillary fossa cleared of the salivary and lymphatic glands, fat, &c., the facial vessels being tied above and below the fossa; the flap is raised further from the masseter and jaw and the buccal mucosa divided at its attachment to the outer side of the lower jaw; the symphysis is then divided with saw and bone-forceps and, retracting this outward, the digastric, mylohyoid, geniohyoid

and buccal mucosa of the inner side are divided. The floor of the mouth or part of the tongue may be removed with the jaw by altering the plane of section at this stage. The internal pterygoid muscle is then divided with the inferior dental vessels and nerves, the former being tied. The jaw is then pulled well down and the temporalis tendon cut away from the coronoid process ; the masseter is cut through close to the zygoma and the external pterygoid divided, taking care not to injure the internal maxillary artery. The half-jaw can now be twisted out from its articular attachments. If the genial tubercle has been removed the tongue must be prevented from falling back over the glottis by a ligature through its tip. The side of the tongue or floor of the mouth is then sutured to the cheek to cut off the wound in the neck from the mouth, and the wound in the former drained after suturing the skin. The remaining half-jaw tends to swing across, but can be kept in position by muscular effort on the part of the patient sufficiently to allow of mastication. Dentists at present have difficulty in providing dentures to fit such cases.

OPERATIONS FOR ANKYLOSIS OF THE JAW. (a) Where the ankylosis is intrinsic the condyle is excised. A horizontal incision an inch and a half long is made immediately below the zygoma, the parotid and branches of the facial nerve displaced downwards, the masseter pushed aside, exposing the external lateral ligament and neck of the condyle, which is cut through with a chisel and the condyle levered out, taking care not to perforate the cranial cavity through the thin glenoid fossa ; plenty of the neck of the jaw should be removed and fascia interposed in the joint cavity. The mouth is gagged open, and if the result is not satisfactory the operation repeated on the other side or a cuneiform resection performed. Another plan is to make the incision a little higher, divide the zygoma in two places, and turn the intervening part down with the masseter, thus giving a good exposure of the joint (Lillienthal).

(b) For extrinsic ankylosis due to fibrous bands a wedge-shaped portion of the jaw is removed with the apex upwards. This is usually done at the angle through an angled incision along the margins of the bone ; the masseter and internal pterygoid are stripped and the wedge removed with a saw. This operation may be done on both sides, and is available where excision of the condyle is too difficult or proves unsatisfactory. The wedge may be removed further forwards and in front of cicatricial bands. In this case, however, excision can only be done on one side, for if done on both sides all power of closing the jaw will be lost. In the first operation flaps of masseter should be turned-in between the ends of the divided bone, and all possibility of further ankylosis is avoided.

CHAPTER XXIX

SURGERY OF THE MOUTH, TONGUE, AND SALIVARY GLANDS

Infections of the Mouth : Mercurial Stomatitis : Ulcerative and Gangrenous
Stomatitis : Chronic Inflammations, Leucoplakia : Affections of the Hard
Palate : Anatomy of the Tongue and Floor of the Mouth : Congenital Defects
of the Tongue : Injuries of the Tongue : Nervous Affections of the Tongue :
Inflammations of the Tongue : Chronic Inflammations, Glossitis : Dental
Ulcers : Tuberculosis of the Tongue : Syphilis of the Tongue : Actinomycosis :
Innocent Tumours and Cysts : Thyroid Tumours of the Tongue : Cancer of
the Tongue : Diagnosis : Prophylaxis : Operative Treatment : Anatomy of the
Salivary Glands : Injuries of the Salivary Glands, Salivary Fistula : Salivary
Calculi : Infections of the Salivary Glands : Ranulæ : Tumours of the Salivary
Glands.

Inflammation of the Mouth. This condition is described in general as
stomatitis, of which we may recognize anatomically and clinically various
grades of severity, viz. catarrhal, ulcerative, gangrenous, which are due to
various infections.

Catarrhal Stomatitis. This is often the initial condition preceding
the more severe forms. The mucosa is hyperæmic, tender, and swollen,
the latter point being particularly noticeable in the tongue, which becomes
sodden and œdematous, showing the impressions of the teeth. This affection
occurs in febrile dyspepsia, from irritation of carious teeth, from scalds,
operations, malnutrition, and in children often is consequent on the exan-
themata.

The inflamed mucosa readily becomes eroded in places and small
whitish-yellow ulcers are found, particularly in children, due to the
bursting of tiny subepithelial abscesses, a condition known as *aphthous
stomatitis*. Infection with the organism of "thrush" (a mould, by name
oidium albicans) produces patches somewhat resembling aphthous ulcers in
children and infants ; the white patches however are not ulcerated but raised,
and there is no hyperæmia around them as with aphthous ulcers, while the
fungus can readily be recognized under the microscope if scrapings be
taken from the patches. All these conditions yield readily to oral antisepsis,
the mouth being washed and swabbed out with dilute permanganate of
potash, hydrogen peroxide, Sanitas 1 in 20, or boroglyceride of the same
strength. If the small ulcers do not heal readily they may be touched with
silver nitrate. At the same time attention is directed to improving the
general condition, or the stomatitis may assume serious proportions.

Mercurial Stomatitis. This usually occurs as a chronic trade poison-
ing, but sometimes where the drug is being administered medicinally, as

some persons are very susceptible and may be poisoned by a single dose. Salivation is an early sign which should be taken as a warning if the drug is being administered. Later the mucosa of the tongue and gums becomes swollen ; the latter become spongy, soft and bleed, the tongue œdematous and may ulcerate ; still later the teeth drop out.

Treatment. The drug is stopped, saline purges and iron tonics given, and the mouth kept clean by attention to the teeth and the use of one of the mouth-washes just mentioned or solution of chlorate of potash twenty grains to the ounce.

ULCERATIVE AND GANGRENOUS STOMATITIS. These terms are applied to the more severe and aggressively advancing forms, for, as has been mentioned, ulceration is often present in the comparatively mild aphthous stomatitis. The less severe form, to which the term ulcerative is usually applied, occurs from infection of slight abrasions due to rough teeth, &c., in persons debilitated from syphilis, scurvy, blood diseases, mercurialism, after exanthemata, &c. A sloughy, foul-smelling ulcer forms on the inside of the cheek or on the gum which spreads with some rapidity. There is considerable constitutional depression.

Gangrenous stomatitis, or Cancrum Oris, is a rapidly advancing, gangrenous ulceration usually met with in debilitated infants and children after measles and scarlet fever, but only occasionally in adults. There are great prostration and abundant foul-smelling salivation streaked with blood.

On examining the mouth there will be found a foul ulcer inside the cheek covered with grey sloughs and advancing with great rapidity ; in a few hours there will be a dusky discoloration of the cheek outside, which soon turns black, and the cheek melts away in foul sloughs surrounded by much œdema, and if treatment be not speedy and drastic the patient succumbs in a few days. Early diagnosis is most essential ; hence the mouth of children suffering from measles, &c., should be kept carefully cleaned and often inspected inside, especially where the breath is offensive. Where healing takes place there is much fibrous contraction and extrinsic ankylosis of the jaw results, requiring operative measures to enable the mouth to be opened.

Treatment. In the ulcerative type it will suffice to remove carious teeth, scrape away sloughs from the ulcer, and paint the floor with pure carbolic, keeping the mouth clean with peroxide of hydrogen lotion and maintaining the strength with generous liquid diet and stimulants. In the case of cancrum oris more radical measures are needed, but above all the operation must be early to be successful. The gangrenous part is cut away freely with knife or scissors till healthy and freely bleeding tissues are exposed, regardless of damage to the cheek, which may of necessity be almost entirely cut away. The raw surface is touched with pure carbolic or the cautery and the mouth kept clean by frequent irrigation with permanganate, peroxide lotion, &c., and the strength maintained as far as possible by suitable diet.

If the patient recover, a plastic operation will be needed to enable the mouth to open properly and to fill in the chasm left.

The bacteriology of this condition is uncertain ; various anaerobes are under suspicion, but are most likely saprophytes living on the slough produced by acute streptococcal infection.

PTYALISM. This term implies excessive secretion of saliva, and may be due to many causes ; for practical purposes it should be recognized that excessive salivation is often an early sign of stomatitis of various sorts, and points to the necessity of inspecting the mouth and inquiring about the taking of drugs (e.g. mercury). Dentition, pregnancy, and bulbar paralysis are also causes.

CHRONIC INFLAMMATIONS ; LEUCOPLAKIA. The chronic hypertrophy of epithelium on a substratum of overgrown papillæ, so commonly found in the tongue and due to the irritation of tobacco and alcohol on a basis of syphilis, is also found inside the cheeks opposite the teeth, which are, no doubt, partly responsible for the irritation. These " smoker's patches," occurring inside the lips or cheeks, are greyish or whitish patches (according to the thickness of the hypertrophic epithelium), smooth and devoid of signs of inflammation. They may, however, later become warty and undergo cancerous changes.

NEW GROWTHS OF THE INSIDE OF THE CHEEK. These take origin in the above-mentioned leucoplakia or independently of these, inside the cheeks opposite the teeth, as warts or squamous-celled cancer, the former tending to pass into the latter. Warty growths in this situation are found in middle-aged men, and, apart from glandular enlargement, the diagnosis of warts from early cancer is not easy, as the induration of the base in the latter instance may be slight at first.

Treatment. Such warty masses should be excised, and if evidence of malignancy be detected on microscopical examination a further and wider excision should be performed and the submaxillary triangle cleared of fat and glands.

AFFECTIONS OF THE HARD PALATE. The superficial inflammations described as stomatitis are not much in evidence on the roof of the mouth.

Suppuration in the mucoperiosteum of the hard palate is generally the result of an alveolar abscess starting in one of the incisor teeth ; an abscess sometimes arises from an abrasion, e.g. from a badly fitting tooth-plate. Such an abscess should be opened and any causative carious stump removed.

Syphilis. The hard palate is a common place for gummata, particularly in the posterior part and in the middle line. An indolent, painless swelling which fairly soon breaks down, discharging a tough yellow slough, is characteristic ; often the bone beneath necroses and a perforation of the palate into the nose results.

Of *tuberculosis* the most common manifestation is lupus spreading from nose and face, which may lead to perforation. Cold abscesses sometimes form here from tuberculosis of the maxilla.

Perforation resulting, from syphilis, when healed can be remedied with an obturator or filled in by a turn-over flap as in operations for cleft-palate.

TUMOURS OF THE HARD PALATE. Adenomas and endotheliomas are found as smooth, slowly growing, non-ulcerating tumours, which are cured by local removal.

Squamous-celled cancer may spread from the gums or originate independently : sarcoma of rapid growth is occasionally found. In the last condition the whole of the palatine process of the jaw, if not the whole jaw, will need removal to give any prospect of cure.

THE TONGUE AND FLOOR OF THE MOUTH

Anatomy. The greater part of the floor of the mouth is occupied by the tongue, which is made up of interlacing muscle-fibres separated in the middle line by the vertical raphe, through which the vascular and lymphatic exchange is of the slightest. The tongue is attached to the hyoid bone and mandible by the hyoglossus and geniohyoglossus muscles. The mucosa of the tongue is firmly attached to the muscular body of the organ, and at the sides is reflected over the lingual and buccal part of the submaxillary glands (the attachment here being loose) to the side of the jaw, where it becomes continuous with the gum. The lingual mucosa is covered with filiform papillæ which undergo changes in superficial glossitis, and it is further divided into anterior and posterior portions by the circumvallate papillæ, which mark its origin from a median " tuberculum impar " and the posterior " furcular processes." In the mid-point of the circumvallate papillæ is the foramen cæcum or upper end of the thyroglossal duct.

In addition to the filiform papillæ are large, scattered fungiform papillæ, which when denuded of epidermis appear as red spots in the condition known as " strawberry tongue." On the posterior part of the side of the tongue are some poorly developed " foliate papillæ," which are chiefly important as being often mistaken for early cancer.

The motor innervation is by the hypoglossal nerve ; sensation is supplied in the anterior part by fibres derived from the chorda tympani running in the lingual nerve, in the posterior part by the glossopharyngeal nerve.

The floor of the mouth at the side of the tongue consists of the sub-lingual and part of the submaxillary gland supported by the mylohyoid muscle, and running across this close under the mucosa are the duct of Wharton, the lingual and hypoglossal nerves, and the ranine vein ; the lingual artery lies deep to the hyoglossus muscle. The lymphatics of the anterior part of the tongue drain into the submental glands but more into the submaxillary ; those of the posterior portion drain into the deep cervical glands about the angle of the jaw, but the nodes above and below this are very soon affected with cancer.

Examination. The tongue and mouth are inspected in a good light ; the movement of the tongue is noted, and its surface should always be dried before deciding on the condition present as regards ulceration, glossitis, &c. Palpation will reveal induration or fixity of the organ and its

surroundings, nodes of cancer in the floor of the mouth, or calculi in Wharton's duct and abscess in this situation.

CONGENITAL DEFECTS OF THE TONGUE. In rare instances absence of the organ is described.

Tongue-tie, or too great shortness of the frænum linguæ, exists more often in the imagination of mothers and nurses than in the mouths of infants, and even if short, can have no effect on sucking or, later, in causing stammering, and as there is no special merit in protruding the tongue a great distance, division of the frænum is not advised. Excessive length of the frænum is also recorded, enabling the patient to pass the organ down the pharynx. If likely to cause suffocation it might be shortened by a plastic operation.

MACROGLOSSIA. This term is applied to enlargement of the organ from the presence of a diffuse lymphangeioma or dilated lymphatic vessels.

This may also be found as an acquired condition from inflammatory blocking of the lymphatics. The large size of the tongue may lead to its bulging between the teeth and being bitten and ulcerated or, later, causing deformity of the jaws. Another cause is neuro-fibromatosis, and the tongue is enlarged in certain idiots, e.g. Mongols.

INJURIES OF THE TONGUE. Lacerated wounds are usually due to biting from falls with the mouth open and the tongue protruded, e.g. in epileptics, or blows received in this position, bullet-wounds, pipe-stem punctures, &c. Such wounds should be cleansed and sutured and careful search made for foreign bodies, which if retained will promote sepsis and dangerous secondary hæmorrhage, for which, owing to the difficulty of securing the lingual in the mouth, ligature of the external carotid may be needed.

NERVOUS AFFECTIONS. *Paralysis* of half the tongue follows injury of the hypoglossal nerve in the neck, of its nucleus in the medulla, or its cortical centre. The tongue deviates to the paralyzed side, and this side becomes flabby and atrophic (the deviation is to be distinguished from the apparent deviation of the tongue in facial paralysis : the mid-point of the incisor-teeth is the landmark by which to make a judgment on this).

Spasm of the organ is also described. Neuralgia along the course of the lingual nerve may form part of trigeminal neuralgia ; if occurring independently it may yield to medical measures or necessitate section of th ; lingual nerve in the floor of the mouth (*see* Surgery of Nerves, p. 674, vol. i).

INFLAMMATIONS OF THE TONGUE. Acute superficial glossitis forms part of acute stomatitis, whether catarrhal, aphthous, mercurial, &c., and has been already described.

Acute parenchymatous glossitis, which may be suppurative and in which the deep parts of the organ are affected, may follow mercurial stomatitis or arise from infected abrasions and punctured wounds.

Signs. The tongue swells rapidly, feels stiff and painful, fills the mouth, and cannot be protruded. There is great difficulty in swallowing and speaking ; profuse salivation is a marked feature. High fever is usually present and enlargement of the submaxillary and deep cervical glands. If

the œdema spreads back to the ary-epiglotidean folds suffocation may become imminent. The affection may subside or suppuration occur, usually in three or four days. In other instances the onset is less acute and an abscess forms in the body of the substance of the tongue, or more often in the sublingual region.

Treatment. Any cause, such as a foreign body, should be removed, and mercurial dosing stopped. The bowels should be opened freely with salines and the mouth cleaned with weak antiseptic lotions. Where there is great œdema, rapidly spreading, the tongue should be incised on either side of the dorsum or into its base in the mid-line of the floor of the mouth, according to the situation of greatest swelling. Where there is brawny infiltration

Fig. 142.   Tuberculous abscess of left side of the tongue.

of the submaxillary region, *i.e.* the condition is approaching that of Ludwig's angina, an opening should be made below the jaw between the digastric muscles into the base of the organ. Preparations should be made to perform tracheotomy, which may become urgent at any moment.

Localized abscesses are opened where most prominent. When in doubt where to open in severe cases, it is well to open the floor of the mouth under the mid-line of the tongue and insert sinus-forceps into the base of the organ.

SUBACUTE AND CHRONIC INFLAMMATIONS. (1) *Chronic Superficial Glossitis, Leucoplakia, Leucoma, Leucokeratosis.* In this condition there are changes in the epithelium and papillæ of the lingual mucosa, caused by irritation acting on tissues which have been in most instances damaged by syphilis ; the irritation may be from tobacco, alcohol, highly seasoned food, irregular teeth, dentures, &c.

The importance of this condition lies in the fact that malignant changes are very likely to supervene sooner or later. The changes of superficial glossitis fall into two groups, hypertrophic and atrophic, the latter of which is often considered to be secondary to the former, but in many cases the conditions are independent from the onset. In the hypertrophic form the papillæ become large and elongate, appearing at first on the surface as red points. The epithelium over these becomes thickened, horny, and does not readily desquamate, so that it is many layers thick, thus forming grey or white patches (leucoplakia), which if the papillæ are very much elongated constitute warty excrescences.

In the atrophic parts the papillæ, with or without previous hypertrophy,

become shorter and flattened, while the epithelium over them consists of only a few layers, so that the tongue in these parts appears smooth, red and glazed, and is often very tender and sensitive. In most instances the tongue presents alternate patches of white leucoplakia and red, glazed, atrophic areas. Cracks or small ulcers develop later, especially in the atrophic parts, and cancerous changes may follow quite soon. Where the condition is entirely leucoplakial without atrophy there may be an interval of twenty years or more before malignant changes take place, the white patches remaining quiescent, painless, and stationary.

Subjective signs vary considerably : pure leucoplakia may persist for long enough without any discomfort, but where there is atrophic glossitis,
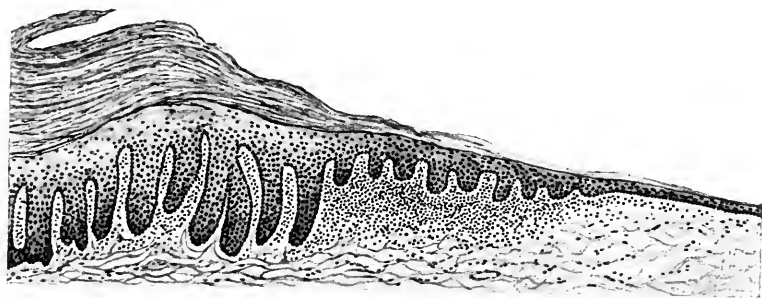
Fig. 143. Leucoplakia and atrophic glossitis (magnified). On the reader's left the hypertrophied papillæ, infiltrated with round cells and surmounted with thickened epithelium, are noted (hypertrophic glossitis or leukoplakia) ; on the right the papillæ are atrophic and the epithelium is reduced to a few layers only (atrophic glossitis of or glazed tongue).

with cracks and fissures or warts, there is much pain and discomfort on taking hot or irritating food or drink. The main importance, however, is the great prospect of cancerous changes.

Treatment. In the early stages irritating diet (mustard, pepper), tobacco, and alcohol should be avoided, the teeth repaired or extracted, and a soothing ointment applied, such as that of boric acid, and a mouth-wash of chlorate of potash ordered ; the surface of the tongue should be painted occasionally with a solution of chromic acid ten grains to the ounce.

Where leucoplakia is well developed these measures are of little use. Neo-salvarsan should be administered as for syphilis, and may clear up the condition most speedily ; should this fail, and especially where cracks or ulcers are present, the affected part should be excised even if most of the dorsum be involved, and sound mucosa sutured over the raw surface. Strong caustics, *e.g.* silver nitrate, are to be rigorously avoided in these cases as predisposing to cancer (Butlin). By removal of the affected part before cancer actually develops the large-sized and yet often ineffectual operations for cancer will be avoided, and operation should be strongly urged if a cracked, ulcerated tongue, the subject of glossitis, does not clear up under administration of neo-salvarsan.

(2) *Dental Ulcers.* As has been mentioned, the irritation of rough teeth, as well as the oral sepsis associated with them, is an important factor in

the production of cracks, ulcers, and glossitis. In addition the sharp edge of a carious tooth may abrade the tongue locally and afford entrance to infection, resulting in the production of a " dental ulcer." Such ulcers are found at the side of the tongue opposite a rough tooth, and are often fairly deep with sloughy floor ; the edge is, however, not everted, and induration, though present when the ulcer has existed some time, is never so great as in cases of cancer, while there is no fixity of the tongue. The diagnosis from early cancer is, however, often not easy, and such ulcers may be the starting-point of cancer. The presence of the offending tooth suggests the diagnosis, and the latter should be removed at once ; then, if the ulcer does not clear up in a few days under measures of local antisepsis, it will be best to excise it bodily and have a frozen section prepared, so that the removal of the organ can be performed at once should the condition prove cancerous.

Fig. 144. Chronic superficial glossitis, showing white patches (leucoplakia) and crack-ulcers (which are likely to become cancerous).
(*Kindly lent by Dr. Gilbert Scott.*)

(3) *Tuberculosis of the Tongue.* This is almost always secondary to pulmonary phthisis and due to contact infection into abrasions from rough teeth. The ulcer is usually near the tip of the tongue, and there may be some induration of the base and the floor covered with small dry granulations ; in other examples there is no induration, but the floor is sloughy with weak, prominent granulations, and the edges undermined or vertical. The former condition somewhat resembles early cancer, but there is no eversion of the edge and less induration.

The position, pain, and tenderness of the ulcer and the condition of the lungs will usually enable a diagnosis to be made ; sometimes small tubercles may be noted surrounding the edge of the ulcer, while glandular enlargement is very common.

Treatment. Where the patient's condition is good and the ulcer very painful it may be worth excising the latter under local anæsthesia, but where the lung condition is too far advanced for such attempts the pain

may be relieved by painting with cocain before meals, dusting with ortho-form, and using weak antiseptic mouth-washes.

(4) *Syphilis of the Tongue.* The tongue may be affected in all stages of the acquired disease, and also, though not commonly, in the congenital form.

(*a*) Lingual chancres may arise from infection with pipes, glass-blowing implements, kissing, &c. The callous, indolent ulcer with indolent secondary bubo in the submaxillary region is suggestive, and the serum reaction or appearance of cutaneous secondaries will clinch the diagnosis.

(*b*) In secondary syphilis occur " mucous patches " or areas of sodden epithelium, which does not desquamate and remains heaped up, found on the tongue, inside of the lips and cheeks. Ulceration may follow or the papillæ under the patches become hypertrophic, forming a papillomatous outgrowth usually on the dorsum of the tongue and known as Hutchinson's wart, which is of the same nature as the hypertrophic, warty condylomas of the genitals.

(*c*) In tertiary syphilis a parenchymatous infiltration takes place in addition to the chronic superficial glossitis already described, which often co-exists with parenchymatous infiltration.

Syphilitic infiltration in the deeper part of the tongue often ends in fibrosis and much scarring, the contraction of the healing gummata leading to deep linear indentations on the surface of the tongue, which may be intersected like a gridiron ; this condition is described as " sclerosing glossitis.'' Where the infiltration is larger or near the surface the resulting gumma may burst on the surface with the formation of a gummatous ulcer ; such gummata vary in size from that of a pea to that of a walnut.

(*d*) Though usually found in the acquired disease, we have seen a lingual gumma in the congenital form.

Signs. Gummata are painless, elastic lumps in the substance of the tongue, affecting its movement but little ; when a gumma begins to soften it may be hard to distinguish from a subacute abscess. When the gumma has burst, the resulting ulcer has steep margins, a hyperæmic edge, and yellow slough on the floor ; surrounding induration is but slight. Often several gummata occur close together, and by their coalescence the ulcer assumes a serpiginous or scalloped form ; as already mentioned, even where the condition is extensive the protrusion of the tongue is little impaired ; the position is usually on the dorsum and posterior portion of the tongue ; glandular enlargement is seldom noted.

Diagnosis from cancer is usually possible from the position, the mobility of the organ, the serpiginous outline, plain unrolled edge, painlessness, slight induration of the base, and absence of enlarged glands. In doubtful instances, however, where improvement on anti-syphilitic remedies is not marked within a week, a portion of the edge should be removed for micro-scopic examination, as cancer may originate in a gummatous ulcer.

Treatment. Neo-salvarsan, iodides, and mercury.

The *lingual tonsil* is subject to acute and chronic inflammations, and will be considered with the faucial tonsils.

INFECTIONS OF THE FLOOR OF THE MOUTH. Allusion has been made already to sublingual abscess, for an abscess situated deep in the substance of the tongue is really in the floor of the mouth. The signs are as in severe parenchymatous glossitis, and treatment consists. in opening the swelling through the mouth, in the middle line, and below the tongue, as soon as suppuration is suspected, for if left unopened the danger of œdema of the glottis is not inconsiderable.

Actinomycosis occurs in the floor of the mouth and tongue as an indolent, brawny swelling ; the mucosa over this becomes red as it nears the surface, and finally it bursts by many small fistulæ. which discharge pus containing yellow granules.

Treatment. Excision and scraping away the mass as far as possible and administration of iodides will cure in many instances.

TUMOURS AND CYSTS OF THE TONGUE. Malignant tumours are far more common than innocent.

Innocent Tumours. Lipomas and fibromas are occasionally found. Their chronicity, well-defined outline, and failure to ulcerate or invade surrounding parts will distinguish from malignant growths, and excision will usually be simple.

Angeiomas are more common, the cavernous nævus being found here, often in conjunction with a similar condition of the lip. Treatment is usually necessary, as they are apt to grow and ulcerate, in which case severe bleeding may ensue.

Treatment. Excision may be possible, but often the nævi are too intimately mingled with the rest of the tongue to accomplish this without a very wide and mutilating removal. Electrolysis or multiple punctures with the thermo-cautery will cure in time. Possibly puncture with a diathermic needle will afford better results in the future.

Mucous cysts, from blocking of the ducts of small mucous glands, are found on the inner surface of the lips, cheeks, and tongue. Their translucent appearance reveals their nature, and they are readily cured by cutting away the superficial wall and touching the interior with pure carbolic.

Ranulæ, or cysts from blocking of the ducts of the larger salivary glands, are found in the floor of the mouth, and are described under the Affections of Salivary Glands (p. 438).

Papillomas, or warts, have been already mentioned as occurring in sequence to chronic glossitis, and as their tendency is rapidly to become malignant, immediate removal is indicated with careful microscopical examination.

THYROID TUMOURS AND CYSTS. The diverticulum in the floor of the mouth, at the foramen cæcum, between the rudiments of the tongue, has been already mentioned as giving rise, by its abnormal persistence, to fistulæ and cysts in the neck (thyroglossal cysts). Improper development of this diverticulum in its upper reaches gives rise to two main conditions :

(a) *Thyroid Tumours of the Tongue* (*Lingual Thyroids*). In this condition there is a formation of thyroid tissue at the back of the tongue in the region

of the foramen cæcum. Such a tumour may cause interference with swallowing and speech, and if cystic degeneration occur may greatly embarrass respiration (the condition then being practically a cystic adenoma of the thyroid). The diagnosis is made by finding a bluish, rounded, elastic tumour with no signs of ulceration at the back of the tongue in a young person. Owing to the prospect of sudden bleeding into a cyst causing urgent dyspnœa, these tumours should be removed by dissection after preliminary laryngotomy and plugging the lower pharynx.

(b) *Lingual dermoids* are the result of persistence of the upper part of the thyroglossal duct, and form cystic swellings in the base of the tongue. Such tumours may present (1) at the back of the tongue in the position of
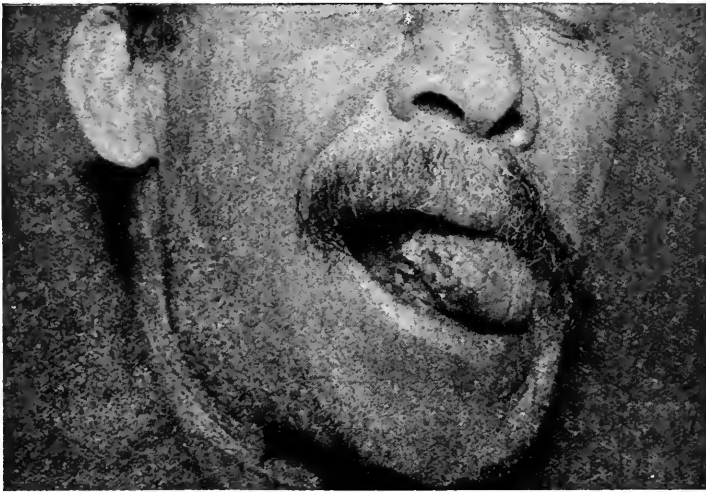
FIG. 145.   Cancerous ulcer of the side of the tongue.
(*Kindly lent by Dr. Gilbert Scott.*)

a lingual thyroid, (2) under the tongue in front, or (3) in the submental space. Such a cyst is distinguished by its yellow colour from lingual thyroids and ranulæ, while the latter are in a lateral position and the dermoid median. These cysts are removed by dissection from the floor of the mouth or under the chin, according to their position.

CANCER OF THE TONGUE. This is practically always of the squamous-celled type (epithelioma), is far more common in men than women (eight to one), and rare under forty.

This disease usually originates in a tongue already affected with ulcers from rough teeth, syphilitic glossitis, irritation of clay-pipes, badly fitting dentures, &c., and is quite the exception in an otherwise normal tongue, which is a great argument in favour of oral and dental cleanliness and order.

The application of strong caustics (especially silver nitrate) is a strong predisposing factor in cancerous growths (Butlin).

The favourite site of cancer is in the side of the tongue (because of the

teeth), but it also occurs on the dorsum, tip, and at the junction of the tongue with the floor of the mouth, the latter being an insidious position and likely to be missed unless the tongue be well drawn on one side and palpation be brought to the aid of vision. It must be fully recognized that cancer starts in several different ways, and if the possibility of obscure cases being cancer be not always in the practitioner's mind he may delay efficient treatment till too late.

(a) Cancer may start as an ulcer on the side of the tongue in its posterior part, resembling a dental ulcer, of which indeed it may be regarded as a variety.

(b) It may originate in connexion with superficial glossitis, usually on the dorsum, as a wart-like growth developing on leucoplakia, or :

(c) As a narrow, ulcerous crack with surrounding hard infiltration.

(d) Sometimes there is much subcutaneous infiltration, while ulceration is long delayed, the growth forming a hard plaque in the side of the organ ; later ulceration will ensue, forming a deep excavation with rolled margins.

(e) When starting at the junction of the tongue with the floor of the mouth the condition is often unnoticed till there is a large ulcer with rolled edge and the movement of the tongue is much restricted. In later stages the ulceration spreads to the fauces, palate, tonsil, jaw, larynx, &c.

Clinical Features. When the condition is well marked there will be an ulcer or infiltration, the former deeply excavated or fungating, with sloughy floor, everted margins, indurated base, the movements of the tongue much restricted, while profuse salivation and fœtor of the breath are notable. The pain is constant and often referred to the ear. Involvement of the submaxillary and deep cervical glands on one or both sides can often be made out on palpation. These break down and ulcerate into the vessels of the neck and on the surface. Death results from secondary hæmorrhage following such ulceration, aspiration-pneumonia, malnutrition from difficulty in feeding, toxic absorption from the ulcerated surface and from swallowing putrid matter, but seldom from secondary internal deposits.

Diagnosis. Very early diagnosis is the only hope of salvation in most instances. Recurrence in the type of case just described is very likely to occur even after the most careful removal of the tongue with the area of lymphatic drainage. Diagnosis has to be made from gummatous, dental, and tuberculous ulcers.

(a) Gummatous ulcers and infiltrations are often multiple, seldom fixing the tongue to any great extent ; the ulcers are punched out, the edge not being everted ; the slough is large, yellow and homogeneous, and as several small gummata often run together, the edge is often serpiginous, while glands are not enlarged ; finally, a positive Wassermann reaction, though good proof of syphilis, does not exclude cancer.

(b) Dental ulcers are in close relation to some rough, carious tooth or denture, the removal of which should be followed by rapid healing, or further investigation will be needed to exclude cancer.

(c) Tuberculosis will be suggested by the condition of the lungs, the

position and character of the ulcer, and possibly by finding tubercle bacilli in the sputum.

It is necessary, however, to suspect cancer in an earlier stage than that described above, *i.e.* while the tongue is still in a condition of superficial glossitis with cracks, warts, plaques, or leucoplakia, or, in other words, in what has been aptly called the " pre-cancerous condition." In this condition the microscope shows that the epithelial cells are not clearly limited from the underlying tissues by a well-defined basement membrane, but merge vaguely into the latter. Even where there is no down-growth of the epithelium the condition should be regarded as early cancer and treated by wide local removal with excision of the lymph-nodes of the drainage area, which will give better results than when the condition is obviously cancer to the unaided senses. To improve the results of treatment of cancer we must rather aim at preventing its development in the early stages by removing doubtful ulcers, warts, plaques, and if microscopically cancerous or suspicious, performing a wider removal with the possibly affected glands. The public still need much educating as to the importance of early attention to any abnormality in the epithelium of the tongue, starting in adult life, and should be informed that if they wait till there are pain and discomfort as well the chances are that operation will be too late to cure, though it may palliate the condition.

Treatment. Prophylaxis. This lies in the hands of the public, of general practitioners, and dentists. The former should be taught the danger of irritating the tongue with clay-pipes, spirits, &c., after middle-life has commenced, especially where there is a history of syphilis. Practitioners examine a great many tongues, not necessarily for affections of this organ, and if any condition of glossitis, &c., be noted the patient should be warned of his danger. Dentists also working constantly inside the oral cavity have opportunities of seeing early stages of these conditions, and can advise consultation for abnormal conditions of the tongue, as well as prevent further irritation by attending to carious teeth or the fitting of dentures. In addition to the prevention of superficial glossitis steps should be taken to induce healing as soon as possible, for although leucoplakia may remain unaltered for years, yet they may become cancerous at any period.

Where cracks, ulcers, warts, or atrophic patches are present the condition is more serious and pressing. The patient should be given a full course of neosalvarsan in addition to local treatment. When the condition does not clear up on his treatment the affected part should be freely excised and the mucosa sutured. The portions removed should be carefully examined microscopically by a competent pathologist, since a determination of the true condition of the mucosa is by no means easy. A few points to assist in diagnosis are given. Where the papillæ are hypertrophied and round-celled infiltration of them is present but the basement-membrane or boundary between the epithelium and dermis is clearly defined the condition is simply chronic inflammation and innocent, no further operation being needed. Where, however, the separation of the epidermis from the underlying tissues

is becoming ill-defined, together with a subdermal infiltration of round cells, the condition should be regarded as early cancer (the " precancerous stage " of some authors). In these cases the glands should be removed, and if the operation on the tongue were on conservative lines it should be done again, removing more freely.

Where obvious down-growth of epithelium and the presence of " cell nests " is found, the condition is definitely cancerous and invasion of the glands and surrounding tissues is probably already advanced. In such cases the tongue should be thoroughly removed on the affected side and the glands completely cleared out. Prognosis will be less good than in the precancerous stage, but better than when the diagnosis was obvious on macroscopical examination alone.

OPERATIVE TREATMENT. Before operative attacks on the mouth, whether of a major or minor nature, the latter should be rendered as aseptic as possible by removing stumps, filling or removing carious teeth, cleaning away tartar, and this should be finished some days before the operation, so that there are no pockets left discharging pus into the mouth. For minor operations the patient is in the dorsal position with the head on one side, but for excision of the whole or half tongue a preliminary laryngotomy should be done and the pharynx plugged with sponges. Before administering the anæsthetic, atropin should be given to diminish excessive secretion of mucus.

(1) MINOR OPERATIONS. Removal of warts and cracks should be done with a wide margin, holding the tongue or wart with a suture, removing all parts affected with superficial glossitis where cracks are present, and the part removed should be well free of the crack in the depth of the tongue. Glands will be removed at a second operation if the condition proves malignant.

(2) Where the condition is manifestly cancer the initial operation will be far more drastic.

Locally the tongue should be removed very wide of the growth, not only in front and behind but below as well, i.e. the geniohyoglossus and hyoglossus should be divided close to the hyoid bone. There is less need to go wide to the side, and unless the growth be near the raphe or very large, one side alone needs removal, but where near the raphe the whole tongue should be removed. In all cases where the condition is clearly cancer or is found to be such on examination the glands should be removed on both sides thoroughly, for often where the cancer is on one side of the tongue glands are affected on both sides quite early.

Having settled how much tongue to remove, the next question is when to remove the glands. It seems bad practice to remove the glands first unless the tongue be removed at the close of the operation, since infection of the space vacated by the glands will continue and the original cancer be growing while the patient is recovering for the second attempt. In a moderate case where the growth is of one side and not greatly advanced, we advocate clearing the submaxillary and deep cervical glands of the

affected side, tying the lingual or external carotid artery, performing laryngo-
tomy, and removing the half-tongue ; removing the glands of the other side
at a second operation ten days later.

By leaving one side of the neck the operation will not be too prolonged,
and there should be ample time to excise the tongue thoroughly without
causing the patient undue shock.   Where the whole tongue is to be removed
this should be done alone, the glands being taken at a second operation.
Where the tonsil or jaw requires removing as well, as it is usually necessary
to open up the neck for such an operation, it will be well to remove the
glands at the same time, as a second operation a few days later, through
tissues matted by the previous operation,. will be difficult and uncertain.

Each case, however, must be judged on its merits, and while a certain
amount of risk from shock and aspiration-pneumonia may fairly be taken
by performing a fairly long operation, yet where the patient is weakly it
may be wiser to run the alternative risk of less efficient removal of glands
by delaying the operation, or even in some instances in leaving them alone.

Preliminary ligature of the lingual artery, if done as an independent
operation especially for this purpose, is not worth the extra time involved
(since with laryngotomy and plugging the pharynx there is plenty of time
to pick up the lingual arteries inside the mouth), but if done while removing
the glands it is only the work of a moment.   In the more extensive cases
the external carotid may be tied above the superior thyroid.

OPERATIONS ON THE GLANDS.   Whether the glands be removed before
or after the tongue, the operation will be on the following lines (Butlin) :
An incision is carried along the anterior edge of the sternomastoid for its
whole length, while a second runs from the centre of this to the symphysis
menti.   Flaps are dissected up, including the platysma, unless the glands
are much involved, when the skin only is taken.   The external jugular is
tied and divided and the sternomastoid retracted.   The carotid sheath is
exposed and the fascia, fat and glands dissected from this in one piece,
tying the veins as found.   The internal jugular vein may be removed if
much involved and the external carotid or its lingual and facial branches
tied.   This dissection is carried upward till the digastric is reached and the
submaxillary salivary and lymphatic glands are dissected out of the sub-
maxillary fossa.   The facial vessels are tied at the lower border of the jaw,
the submental glands and fat cleared out.   In the upper part of the wound
the lower part of the parotid and its lymph-nodes are removed.   The
dissection, in fact, leaves only the internal carotid and vagus with its
branches.   The spinal accessory and hypoglossal nerve, the internal jugular
vein and external carotid, may be removed if necessary, though not as a
routine procedure.

REMOVAL OF THE TONGUE.   In all cases, except for the removal of slight
and doubtful ulcers, a preliminary laryngotomy is advisable, as the excision
can be carried out more exactly and one can make sure that the growth is
widely removed.   Removal without laryngotomy is not difficult, but to
remove the organ thoroughly so that recurrence is unlikely needs care and

attention to detail, and for this reason laryngotomy is advised. The type of operation advisable depends on the extent of the growth.

(*a*) Where the growth is not very large and is confined to the tongue the intrabuccal method of Whitehead will suffice.

The mouth is gagged well open and the tongue drawn out by a ligature through each side of the tip. If half is to be removed the organ is split with scissors along the raphe to at least an inch behind the growth. The mucosa of the floor of the mouth is divided close to the jaw and the sublingual salivary gland raised with the half-tongue. The anterior pillar of the fauces is next divided, the tongue drawn further forward, and its attachments to the hyoid bone (the hyoglossus and geniohyoglossus) divided close to the latter ; the tongue is then drawn still further out and the remaining posterior part divided. The lingual artery may be picked up on the face of the stump or, more neatly, before the lower attachments of the tongue are divided by carefully dividing the hyoglossus, when the artery will be found underneath and may be secured.

Bleeding-points are secured and the mucosa of the tongue stitched over the raw surface to prevent infection of the latter.

(*b*) Where the whole tongue is to be removed the operation can be performed on similar lines without splitting the organ. Its attachments to the genial tubercle of the lower jaw are divided, the tongue pulled forward, and the anterior pillars of the fauces divided ; the mucosa of the floor is then divided and the sublingual glands separated with the tongue. The lingual artery, if not previously tied in the neck, is secured on each side in turn by dividing the hyoglossus, and after dividing the posterior part of the tongue the stump is sutured to the alveolar mucosa.

Where the growth extends to the floor of the mouth or very deep into the organ a wider exposure is advisable.

(*c*) The method of Syme, sometimes called Kocher's operation, may be employed in such cases. The lower lip is split in the mid-line to well below the chin, and the lower jaw, after being drilled for a wire, is divided in the middle line (the line of division should be angled to prevent displacement of the fragments). Retracting the sides of the jaw, the tongue and floor are exposed, though the access is not as good as might be expected ; the whole tongue and floor of the mouth, with the sublingual glands, can be removed, and after suturing the mucosa as well as possible the jaw is secured with a wire through the holes already bored and the lip sutured ; the submental space is drained. There is some chance of non-union of the jaw taking place, and as the exposure is not so very good the method is but seldom commendable.

(*d*) Where the growth is encroaching along the floor of the mouth and is adherent to the jaw, some of the latter must be removed.

In some of these cases it may be possible to saw off the alveolar margin of the jaw in continuity with the growth, leaving the dense lower margin to preserve the integrity of its arch. The lower lip is split as in Syme's operation to afford access to the jaw and a sufficiency of the alveolar margin

and body removed, leaving three-eighths of an inch of the dense border. This gives a good exposure to the floor of the mouth, better than by Syme's operation, and the whole tongue is removed with the portion of jaw.

(e) Where the adherence of the growth to the jaw is more complete the whole width of the latter must be removed opposite the tumour and the portions of jaw united with a plate, which may be covered in by the tissues if all goes well.

(f) Where the cancer is spreading back to the fauces and tonsil it will be necessary to split the jaw in front of the masseter, previously opening the neck by an incision as for removing the glands and clearing out the submaxillary triangle. Then, having split the jaw, the portions are retracted and the whole or half tongue, tonsil, palate, and lateral wall of the pharynx, if need be, are removed in one piece.

In the more extensive operations the mortality is greatly increased and becomes a serious consideration, but owing to the miserable condition of these patients if left without operation, almost any risk is worth taking ; and at the worst, speedy death from shock or aspiration-pneumonia is better than a lingering end from a foul, ulcerated mass in the mouth and pharynx, together with the gnawing pain from involvement of the branches of the trigeminal nerve.

After-treatment. The laryngotomy tube and sponges in the pharynx may be removed at the close of operation, when all bleeding has been satisfactorily checked and the mucosa sewn over the raw surface. A ligature is left through the stump of the tongue for some hours till all danger of suffocation from the tongue falling back has passed. In the less severe operations the patient should be made to sit up as soon as possible to assist in coughing and preventing bronchial catarrh or pneumonia, but the more shocked patients may be kept with the feet elevated for several hours or even days to diminish shock, and also that the secretions may run out of the mouth and not down the trachea ; but as soon as the patient can cough well he should be propped up in the sitting position. Atropin and expectorants should be given where there is any sign of pulmonary congestion or œdema.

The mouth is kept clean by gentle irrigation with weak carbolic and peroxide lotions ; much swabbing is to be avoided. Feeding is managed by a feeding-cup, with rubber tube attached, passed well into the pharynx (this should be practised for a few days before the operation). Where the wound in the mouth and pharynx communicates with that in the neck the latter must be freely drained, or infection may spread to the deeper planes of the neck, mediastinum, &c. The main danger is from aspiration-pneumonia, which is likely to occur in the type of a patient suffering from cancer of the tongue, who will often be found to be emphysematous and bronchitic at the outset.

TREATMENT OF INOPERABLE CASES. The pain may sometimes be relieved by cutting through the lingual nerve as it crosses the floor of the mouth opposite the last molar tooth, but the relief is seldom of long duration. The

mouth is kept as clean as possible by dealing with teeth, stumps, &c., and using antiseptic washes and powdering with orthoform. Morphia will be needed in the last stages.

Where feeding is a difficulty gastrostomy may be considered, but we may well doubt if it is justifiable to prolong life in such cases. Where the larynx is involved tracheotomy for dyspnœa may be indicated.

AFFECTIONS OF THE SALIVARY GLANDS

Anatomy. The *parotid* gland lies for the most part behind the ramus of the jaw, in front of the mastoid process and sternomastoid muscle; deep to the gland are the styloid process and its muscles, the internal jugular vein, internal carotid artery, the vagus, hypoglossal, glossopharyngeal, and spinal accessory nerves. The external carotid and its terminal branches lie in the gland, while the facial nerve passes out through the gland in about its middle behind the carotid. The gland is separated from the submaxillary by the stylo-mandibular fascia. Lymph-nodes lie in and around the parotid gland, receiving drainage from the mid-scalp, outer and middle ear, and orbit, &c. The pars socia of the gland lies over the masseter and the duct of Stenson crosses this muscle half an inch below the zygoma, to end in the mouth opposite the second upper molar tooth.

The *submaxillary* gland is for the most part subcutaneous in the submaxillary triangle between the body of the jaw and the digastric muscle, lying on the mylohyoid and hyoglossus muscles. The deeper part of the gland is above the mylohyoid muscle in the floor of the mouth. The facial artery traverses the gland. The duct of Wharton passes from the deep part of the gland, at the inner side of the sublingual gland, to its opening on the side of the frænum linguæ; the duct is crossed by the lingual nerve. Several lymph-nodes lie in and about the submaxillary gland, receiving drainage from the tongue. The *sublingual* gland lies in the floor of the mouth under the mucosa and upon the mylohyoid muscle; its ducts debouch into the mouth by several openings along the frænum linguæ.

INJURIES OF THE SALIVARY GLANDS. The glands may be cut in accidents, or more often in surgical operations. In most instances healing is rapid and complete, but occasionally a salivary fistula results, *i.e.* the wound does not heal and a clear fluid (saliva) is discharged, especially at meal-times. Where the wound is of the parenchyma the condition is seldom of long duration, but if the main duct be involved it is persistent and difficult to cure.

SALIVARY FISTULA. This affection practically only arises from wounds of the duct of Stenson in the cheek, whether from accident or operation. The duct of Wharton lies so much deeper that it is not likely to be divided except in wounds of the floor of the mouth, in which case the fistula is into the mouth and of no consequence. With a fistula of Stenson's duct, however, the part beyond the injury may contract and all the saliva be discharged on the cheek, causing irritation and inconvenience, and is naturally more abundant at meals. The condition is obvious as a small

sinus of the cheek with pouting granulations discharging clear fluid, which increase, when eating or thinking of food. Treatment is difficult and tedious. Merely freshening the edges of the fistula and suturing are seldom successful, since it is often impossible to re-establish the permeability of the buccal portion beyond the fistula. In such cases the only way is to form a new fistula into the mouth by driving a tenotome from the fistula into the latter and keeping a rubber tube in this new fistula leading into the mouth, till epithelium has lined its interior, when the opening on the cheek will close; the tube is kept in position by a silk thread coming through the original fistula and fastened round the ear. Some months must elapse before the tube can be safely removed (Fig. 146).

SALIVARY CALCULI. These are fairly common in the duct of Wharton (owing to its more viscid secretion), and are formed of carbonate and phosphate of lime. True calculi are very rare in Stenson's duct, though blocking with epithelial debris sometimes occurs.

Signs. These are not obvious till the calculus has attained some size and blocks the duct, causing the gland to swell and become painful, especially during meals. On examination the gland is found enlarged and tender, while a hard mass may be felt in the course of the duct by palpating

FIG. 146. Treatment of parotid salivary fistula. *a*, Stenson's duct (normal part). *b*, Small rubber tube, to which is attached a ligature coming through the fistula. *c*, Impervious part of Stenson's duct beyond the fistula.

in the floor of the mouth, and a probe passed along the duct will impinge on the hard calculus. The hard mass may be mistaken for cancer of the floor of the mouth and the enlarged submaxillary gland for secondary lymph-nodes; exploration of the duct with a probe will reveal the nature of the swelling.

Treatment. The duct is opened over the calculus through the floor of the mouth, the calculus removed, and antiseptic mouth-wash ordered.

Suppuration not infrequently arises where the stone is impacted in the duct (this is a cause of sublingual abscess), and the latter may ulcerate into the floor of the mouth and so escape.

Stenosis of the duct may follow and persistent swelling of the gland, which becomes inflamed and fibrous.

Treatment. In such cases an attempt should be made to enlarge the lumen of the duct with probes or to establish a fistula into the mouth behind the stricture. Where these measures fail the gland should be removed; this is easy in the case of the submaxillary gland, which is the only one likely to be thus affected.

INFECTIONS AND INFLAMMATION OF THE SALIVARY GLANDS. These arise as blood-borne infections or from passage of infection up the ducts, the result of oral sepsis.

Mumps or *epidemic parotitis* may affect any or all of the salivary glands, as well as the testis and pancreas. The infecting organism is unknown

FIG. 147.   Chronic tuberculous lymph-node in the left parotid simulating a parotid tumour.   (Girl of 15.)

and the disease is characterized by rapid swelling of one or more of the above glands, with fever, and difficulty of opening the mouth ; suppuration never results. It is distinguished from enlargement due to blocking of the ducts by the rapid onset, fever, and by the swelling being unaffected by taking food ; from infection *via* the ducts by the absence of the debilitated condition, abdominal disease, oral sepsis, &c., which are the precursors of the latter condition ; from affections of the lymph-nodes, by the boundaries of the swelling corresponding to the salivary glands. Mumps characteristically comes on suddenly in young healthy persons.

Suppurative parotitis may be pyæmic, *i.e.* from blood-borne infection, but more often arises through the ducts.

Ascending infection *via* the ducts is initiated by oral sepsis and occurs in various debilitating conditions, whether acute, as in enteric, typhus, appendicitis, scarlatina, gastric ulcer; or chronic, as diabetes, general paralysis, and various toxic conditions from lead, mercury, iodides, &c. It also arises after abdominal operations, especially on the pelvis, even where these are void of suppuration.

Pathologically the major part of the inflammation is found around the ducts, which are blocked with debris (Bucknall).

Signs. Tenderness and swelling of the affected glands, while the brawny swelling and fluctuation of suppuration may be obvious in the more severe cases and is of grave significance.

The condition seems to be less common in surgical practice than formerly, probably owing to earlier operations on cases of severe abdominal infection (appendicitis, cholecystitis, &c.), the less prolonged rest in bed, and above all, to the better appreciation of the importance of oral sepsis and care of the mouth in these patients.

Fig. 148.   Innocent (mixed) tumour of right parotid gland.   (Woman of 56.)

Treatment. The mouth should be carefully cleaned all through the course, and in the early stages fomentations applied to relieve pain ; when suppuration is suspected the abscess should be opened, incising the parotid transversely to avoid the facial nerve and the duct, using sinus-forceps to avoid injuring the carotid, and draining freely. Suppuration may track into the temporomaxillary joint or into the cellular planes of the neck, causing a variety of Ludwig's angina, while ulceration into large vessels will cause rapidly fatal secondary hæmorrhage : facial paralysis sometimes results. *Chronic inflammations* of the parotid and submaxillary glands, apart from blocking of the duct, also occur ; the pathology is obscure and the condition often recurrent : massage of the gland may improve matters.

Enlargement of the parotid is distinguished from enlargement of the lymph-nodes which it contains, by the socia being unaffected in the latter case, while there will be no alteration on taking food and the duct will be patent.

Acute suppurative infections of the sublingual glands present practi-

cally the same signs as those of the oral floor, and the treatment is similar.

Tuberculosis of the salivary glands only results by extension from the lymph-nodes in their vicinity. The condition resembles a localized tumour
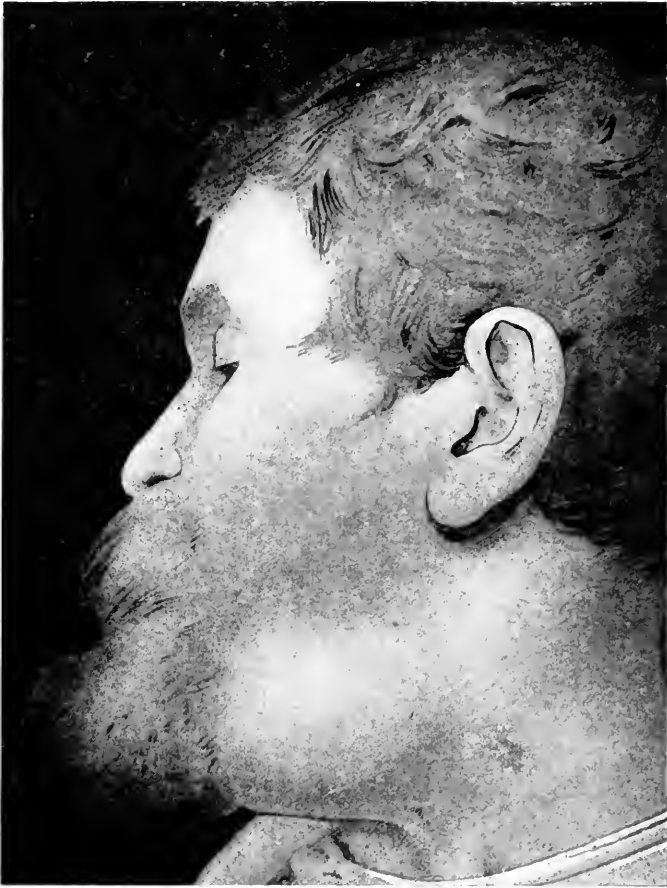
Fig. 149. Innocent tumour of the submaxillary salivary gland.

of the salivary gland (mixed tumour), but grows more rapidly and usually breaks down into a cold abscess in a few months, though we have seen cases still solid after some years. The fact that tubercle occurs in childhood and that other glands are usually enlarged will assist in making a diagnosis, for physically there is little difference (Fig. 147).

Such glands are removed by dissection.

CYSTIC AFFECTIONS OF THE SALIVARY GLANDS (ranulæ). These bluish-grey cystic swellings on the floor of the mouth are due to blocking of the ducts of certain of the salivary glands. Most often some of the ducts of the sublingual glands are affected and the part above distends and degene-rates. Less often ranulæ are due to dilatation of Wharton's duct, in which

case the cyst is not only in the floor of the mouth, but, owing to the length of the duct and its course from below the mylohyoid muscle, there is also a swelling in the submaxillary region. These cysts, then, are akin to the mucous cysts of the lip but much larger.

Signs. The ordinary *sublingual ranula* forms a gradually increasing swelling at one side of the floor of the mouth, which ultimately pushes the tongue up and interferes with speech and deglutition. The translucent, bluish colour distinguishes from a dermoid, which is yellow, while inserting a probe into Wharton's duct proves that the latter is normal.

Treatment. Ranulæ, whether sublingual or due to distension of the glands of Blandin or the incisive glands (which also may be thus affected), are readily cured by cutting away the upper layer of the cyst and touching the inside with pure carbolic, which is then carefully removed, and the wound heals by granulation. The larger *submaxillary* form is dissected away, by an incision under the jaw, and removed with the submaxillary gland.

Fig. 150. Malignant tumour of the parotid gland showing its limits.

New Growths of the Salivary Glands. Innocent and malignant forms are found.

(*a*) Innocent mixed tumours are found in the parotid and submaxillary glands, rarely in the sublingual. They are slow-growing with a definite capsule, and on section are found to be made of various tissues, adenomatous, cartilaginous elements being embedded in a matrix of myxomatous or apparently sarcomatous material. They are regarded by some as endotheliomas, by others as embryonic relics of the gill-arches.

Diagnosis. The chronicity, well-defined outline, mobility, painlessness, and in the case of the parotid the non-involvement of the facial nerve, at once separate them from malignant tumours. From the more chronic

forms of tuberculosis of associated lymph-nodes the diagnosis is not easy if the latter do not break down. The tumours may attain a weight of several pounds, and after years of slow, innocent growth may suddenly take on invading and malignant tendencies.

Treatment. These tumours are readily enucleated by dissection, in the case of the parotid tumour employing blunt dissection to preserve the facial nerve : recurrence is unlikely. Removal is always indicated owing to the chance of malignancy supervening after many years.

(b) *Malignant Tumours.* These are usually cancerous, less often sarcomatous or the result of malignant changes in the innocent type.

Clinically they are distinguished by rapid growth, fixity, ill-defined outline, radiating pain, and involvement of nerves, *e.g.* the facial where the parotid is affected. Owing to involvement of deep structures, the tumour becomes fixed and later ulcerates through the skin : enlargement of neighbouring glands gives a clue to the condition. The above points will serve to distinguish from innocent growths, and prognosis is gloomy even if operation be possible.

Treatment. Thorough removal with the deep cervical glands should be done where possible. This will not be so difficult in the case of the submaxillary, but for the parotid will seldom be justifiable, as the growth is often fixed to deep structures and involves the skin too much.

The facial nerve must be sacrificed (this is of small account as it is either paralyzed or will soon become so). A T-shaped incision is made, the vertical along the sternomastoid, the horizontal along the zygoma ; the external carotid is tied and the angle of the jaw removed with the growth, or the latter divided in front of the masseter and drawn out of the way as in operations on the pharynx, which may be opened in the deeper part of the dissection.

SURGERY OF THE TONSILS, PHARYNX AND ŒSOPHAGUS

Anatomy of the Palate and Oral Pharynx : Acute Inflammations of the Tonsils and Pharynx : Gangrenous Ulceration of the Tonsils and Pharynx : Acute Infections of the Tonsil : Quinsy : Chronic Pharyngitis : Hypertrophy of the Tonsils, Tonsillar Sepsis : Diphtheria : Tuberculosis and Syphilis of the Oral Pharynx : Retro-pharyngeal Abscess : New Growths of the Tonsils and Pharynx : Examination of the Lower Pharynx, Larynx, and Œsophagus : Anatomy of the Œsophagus : Congenital Defects : Injuries of the Œsophagus : Foreign Bodies in the Œsophagus : Stenosis of the Œsophagus, Hysterical, Cardiospasm, Fibrous Stricture, Cancer of the Œsophagus : Pouches and Diverticula of the Œsophagus.

The Soft Palate, Tonsils, and Oro-pharynx (mid-pharynx). *Anatomy.* The middle or oral pharynx is situated between the level of the hard palate above and the epiglottis below, and is separated from the nasopharynx by the soft palate, when the latter is raised in swallowing or mouth-breathing, it opens below into the lower pharynx and larynx, in front into the oral cavity through the fauces, which are made up of the soft palate, tonsils, and base of the tongue. The wall of the pharynx is muscular, lined with mucosa which contains follicles of lymphoid tissue, liable to become inflamed. The tonsils are masses of lymphoid tissue covered with mucosa and penetrated to a varying depth by crypts or follicles, also lined with mucous membrane. They are situated between the pillars of the fauces, *i.e.* the lateral attachment of the soft palate to the pharyngeal wall, and are surrounded by the peritonsillar lymph-spaces, which render enucleation of the tonsil usually a simple matter and infection of which gives rise to peritonsillar abscesses.

Inflammations of the Oral Pharynx (acute pharyngitis, tonsillitis, catarrhal tonsillitis). This is a common complication of acute rhinitis or coryza and due to various organisms—B. catarrhalis, pneumococci, &c. The tonsils, soft palate, and pharynx become slightly painful and red ; enlargement of the cervical glands may be noted ; while the secretion is increased and of mucoid nature, sometimes mucopurulent. This condition is often a symptom of measles, scarlatina, influenza, &c.

Treatment. Abstention from tobacco, and hot, irritating food ; gargling or sucking potassium chlorate or using a spray of menthol and eucalyptus dissolved in parolein will relieve the condition, which is usually evanescent.

Ulcerative Pharyngitis and Tonsillitis ; Septic or Hospital Sore-Throat. This is a more severe degree of infection found in persons situated in bad surroundings, in depressed health, or where a more virulent

strain of organism (*e.g.* streptococci) is present in the throat. The tonsils and pharynx are congested and swollen, small ulcers being seen in either situation ; the cervical glands are markedly enlarged, there is high fever and much depression. Such cases, if neglected, may run on to phlegmonous inflammation with severe ulceration or streptococcal septicæmia may develop.

Treatment. Removal to better surroundings, maintaining strength with nutritious but light diet and stimulants, cleansing the fauces with irrigations of dilute peroxide, permanganate solution or chlorine-water. In the more severe cases tracheotomy may be needed for œdema of the glottis.

GANGRENOUS AND PHAGEDENIC ULCERATION OF THE TONSILS AND PHARYNX. This may follow on the last condition, but is more often met with in patients, especially children, suffering with diphtheria or scarlatina. The inflammation is very acute, great œdema and redness of the fauces and pharynx are present (sometimes called erysipelas of the fauces), and destructive ulceration of the palate, tonsil, and pharynx proceeds rapidly ; involvement of the larynx may cause severe and early dyspnœa, and constitutional signs are severe. The prognosis in such cases is grave.

Treatment. The local condition is treated with antiseptic douches, curetting and painting the ulcers with pure carbolic. Tracheotomy will often be needed. Recovery is rare unless the affection be due to diphtheria, when a timely injection of anti-diphtherial serum will rapidly alter matters for the better. Hence in doubtful instances such injection should be made without waiting to secure bacteriological corroboration of the diagnosis, or valuable time will be wasted, while should the condition be not due to the diphtheria bacillus no harm will be done.

Note. In all the above conditions infection of the middle ear is a common complication, and inspection of the drum should be made at frequent intervals should the patient be too ill to complain of earache.

ACUTE INFECTIONS OF THE TONSIL

FOLLICULAR TONSILLITIS. In this affection the tonsil becomes painful, tender, enlarged, red and swollen, while the crypts become filled with yellowish plugs of desquamated epithelium and organisms ; there is considerable fever and malaise ; recurrence is common. Sometimes the yellow plugs spread on the surface of the tonsil, giving the effect of false membrane, which is distinguished from that of diphtheria by its yellow colour (diphtherial membrane is greyish-white), ill-defined outline, and by taking cultures. Where, however, the patient is very ill and there is any doubt, a prophylactic dose of diphtherial anti-toxin should be given while settling the diagnosis bacteriologically.

Treatment. The condition will subside under gargle of potassium chlorate and aspirin internally. But where recurrence is frequent and the tonsils remain enlarged these should be removed during a quiescent interval.

ACUTE SUPPURATIVE PERITONSILLITIS ; QUINSY. This is due to an infection of the peritonsillar lymph-space with pyogenic organisms, which

doubtless enter through the tonsils, though in most instances the latter are but little affected.

Signs. The onset is sudden, with pain on the side affected and difficulty of swallowing (just as in ordinary tonsillitis), but the general signs are more marked, an initial rigor being frequent, and there is high fever and much depression. The local condition becomes more and more insistent and respiration is impeded, especially during sleep, if the patient can sleep owing to the excessive pain and discomfort. On examination the tonsil is seen to be pushed downwards and inwards by a swelling in the soft palate, which is red or purple, smooth and œdematous, and may block up the fauces pretty completely. The uvula is often œdematous, and where the abscess is very large there may be difficulty in opening the mouth ; the cervical glands are often much enlarged.

Diagnosis. From tonsillitis the fact that the swelling is in the soft palate, is much larger than that found in the latter condition, and almost obscures the tonsil will distinguish. From the more severe forms of pharyngitis, as met with in scarlet fever, phagedenic ulceration, &c., the localization of the inflammation to one side (as a rule), the absence of ulceration, fœtor, signs of scarlet fever or diphtheria in the shape of rashes or membrane, will distinguish. It should be noted, however, the quinsy may be bilateral, but in such

Fig. 151. Incision for a quinsy or peritonsillar abscess.

instances one side is usually more advanced than the other, and the smooth, œdematous, forward bulge of a quinsy is unmistakable when a few cases have been seen. The dyspnœa is usually due to partial blocking of the mouth and nasopharynx, but the inflammation may spread to the upper larynx and become most dangerous.

Treatment. The abscess should be opened as soon as it can be diagnosed with certainty ; before this pain may be alleviated by gargles, soothing lozenges, and fomentations to the neck.

A quinsy is opened by incising it with a sharp knife in its most prominent part, which is in the soft palate, to the outer side of the tonsil, usually midway between the uvula and the last molar-tooth. If pus be not struck at the first incision (it may be at some depth) sinus-forceps are thrust directly backwards in the incision. Anæsthesia is unnecessary and dangerous, as the pus may be aspirated into the lungs. The relief when the abscess is evacuated is enormous. Gargles of weak antiseptics will complete the cure. Where several quinsies recur at frequent intervals the tonsils should be removed in a quiescent period.

CHRONIC PHARYNGITIS. This condition results from chronic infection and irritation, which may be caused by defects in the nasal mechanism,

such as a deflected septum, spurs, chronic rhinitis, suppuration of the accessory sinuses, &c., *i.e.* improper regulation of the upper airway. Local irritation is another potent cause, such as alcohol, tobacco, highly seasoned food, dust, shouting. Two main forms are recognized : (*a*) the granular, (*b*) the atrophic.

(*a*) *Granular pharyngitis* is very largely due to speaking aloud for an excessive time or with exceeding vehemence or prolonged shouting, and is therefore common in parsons, hawkers, and other public speakers (hence the synonyms " parson's " or " huckster's sore throat ") ; usually there is in addition some nasal defect.

Signs. There is a feeling of weakness or irritation of the throat, glairy mucus is produced in excess and frequently hawked up, the voice readily tires and becomes weak and husky (chronic laryngitis commonly accompanies this condition). On examination there is a general congestion of the palate, fauces, and pharynx (the dilated venules being obvious), and enlarged red, lymphoid follicles are seen on the back and sides of the pharynx, the most notable collection being often seen on the side of the pharynx behind the pillars of the fauces, forming a red granular mass (lateral pharyngitis).

Treatment. Irritating food and drink are to be avoided, tobacco cut down to a minimum, and the function of speech reduced. Attention is paid to the nose ; spurs, deviations and adenoids removed ; astringent gargles such as alum, or daily painting with Mandl's solution (iodine grs. 6, potassium iodide grs. 12, oil of peppermint minims 5 to the ounce of glycerine), while a throat-spray of 20 grains each of eucalyptus and menthol to the ounce of parolein is useful. The larger follicles, especially at the sides of the pharynx, may be cauterized with the electric cautery or chromic acid fused on a probe.

(*b*) The *atrophic form* is usually associated with atrophic rhinitis or suppuration of the accessory sinuses, such as the sphenoidal.

Signs. The throat feels dry and uncomfortable and the voice is weak. On examination the pharynx is dry and glazed ; white crusts form in the upper pharynx from drying of the viscid secretion.

Treatment. Attention to the nose is the first measure, dealing with atrophic rhinitis or sinus suppuration ; the pharynx is cleansed of crusts with sprays or alkaline douches and care taken as regards food and drink, as in the hypertrophic form.

HYPERTROPHY OF THE TONSILS ; TONSILLAR SEPSIS. Enlargement of the tonsils is due to chronic, and is the cause of acute inflammation, being found most often in children and young adults, often associated with adenoids.

Anatomy and Effects. There is excess of fibrous tissue as well as increase of the lymphoid elements ; the crypts are extra deep, and concretions in these are common. Associated as this affection often is with adenoid vegetations, the results of the latter condition are frequently marked, viz. breathing through the mouth, snoring, diminished intelligence, and otitis

media ; while repeated attacks of acute inflammation (tonsillitis) are common. Various conditions are found :

(*a*) In most instances the tonsils are obviously large and protuberant, standing out from between the pillars of the fauces and perhaps meeting in the middle line, causing, in the more marked instances, difficulty in breathing, defective speech, and difficulty in swallowing.

(*b*) In other cases the projection of the tonsils from between the pillars of the fauces is only moderate, but they extend deeply between the latter towards the lateral wall of the pharynx. Such " buried tonsils " may present but little signs of enlargement till they are enucleated for recurrent attacks of inflammation.

(*c*) In, again, other instances the tonsils are not really large at all, being flat, but are in a state of chronic inflammation (the crypts being plugged with concretions) with frequent acute exacerbations, and the cervical glands are enlarged. Such tonsils are foci of sepsis, and certainly should be removed.

Tubercle bacilli have been found fairly often in such hypertrophied tonsils, even though the tonsil does not show the characteristic inflammation due to the bacillus ; hence enlarged tonsils may be suspected of being the point of origin of tuberculous glands of the neck.

Treatment. Where the tonsils are distinctly enlarged, and if this be combined with repeated attacks of tonsillitis, otitis media, and mouth-breathing (the adenoid syndrome), removal of the offending organ is indicated, as it is in cases where there is no obvious hypertrophy but repeated attacks of tonsillitis, follicular or simple : such tonsils are not likely to heal on gargles, &c., while they are sources of infection and may lead to serious trouble in the near future. Where there is merely slight enlargement without other signs, astringent gargles, tonics, open air, and breathing exercises should be advised first.

Operative Treatment. Two operations hold the field at present, removal with the guillotine and enucleation ; the merits of each are strongly asseverated by different authorities. There is undoubtedly scope for both methods : where the idea is to remove a septic focus, in the case of a buried tonsil, enucleation is indicated ; where the tonsil is very protuberant and its sepsis small, removal with a guillotine may be quite reasonable, as little will remain and we may expect fibrous scarring to obliterate that little. Enucleation has the advantage that, besides removing the whole organ, there is no need of special instruments, a scissors and volsellum being all that is needed ; the guillotine has the merit of rapidity, but is only suitable for very protuberant tonsils. The latter can be used without an anæsthetic, but in most instances it is better to employ the A.C.E. mixture, the patient not being very deeply under, so that the coughing reflex soon returns.

(*a*) *The Guillotine.* There are many forms of this implement ; the Mackenzie type is as good as any, and care should be taken to see that the blade is sharp. Having anæsthetized the patient, the mouth is gagged open, the head being in the middle line. The blade of the guillotine is

drawn back and the loop passed over the tonsil, the engagement of the organ in the latter being felt with the finger of the disengaged hand. The anaesthetist pushes the tonsil further into the loop with finger behind the angle of the jaw, while the operator presses the loop of the instrument further outwards to get as much tonsil into the loop as possible. The blade is then thrust home with the disengaged hand (this hand should never be palpating the tonsil while the blade is being forced home, or if any bungling takes place a good slice may be removed from the finger). The right hand holds the handle of the guillotine when removing the left tonsil, while the hands are reversed for the right tonsil; or the surgeon, if weak in the left hand, may stand above the patient's head and still have the right hand on the handle. Protuberant tonsils are practically enucleated by this method.

(b) Enucleation is advisable for flat or buried tonsils. The head is on one side. The forefinger of the right hand is introduced between the anterior pillar and the tonsil; with a few up- and down-strokes the mucosa is torn through (where the latter is tough it may be divided between the pillar and tonsil with scissors); the finger enters the peritonsillar lymph-space and sweeps above, between the tonsil and soft palate, then behind, so that the tonsil is raised from its bed, when it only remains attached by the mucosa at its lower end and may be seized with volsellum-forceps and twisted off or removed with scissors. This operation may be done by touch alone, as in suprapubic enucleation of the prostate; the only difficulty is finding the proper line of cleavage at the commencement. When in doubt enucleation is the operation of choice. After the operation is finished the patient is turned over on the face to allow blood and mucus to escape until the coughing reflex is well established.

Cold liquid food is advisable for the next few days, and where there are any signs of inflammation irrigation with weak carbolic lotion. Bleeding usually stops in a few minutes, but if persistent, sponges steeped in adrenalin should be thrust into the raw surface, while in worse cases it may be worth suturing the pillars of the fauces together with deep stitches. Ligature of the carotid will hardly be indicated unless some extraordinary catastrophe, such as injury to the internal carotid, has taken place.

When operating on the tonsils examination is always made for adenoids, and these removed if present.

SPECIFIC INFECTIONS OF THE PHARYNX AND FAUCES

Diphtheria. The fauces are the common situation for infection with the diphtheria bacillus. The greyish-white, false membrane is characteristic, and forms not only on the tonsils, but spreads to the soft-palate and pharynx. The onset is very like other acute infections of the oral pharynx with malaise and fever, but the latter is usually less than in acute tonsillitis, while the constitutional depression is greater; early glandular enlargement is a marked feature.

Diagnosis. In small children the membrane must not be mistaken for milk-curds or thrush, in neither of which will there be signs of general infec-

tion, while removal of the diphtheritic membrane leaves a raw bleeding area, which is not the case in the other conditions. In older persons the spread of muco-pus from a follicle of the tonsil may suggest diphtheria, but this is confined to the tonsil and is yellowish in colour, while the fever is greater and the constitutional depression less. In doubtful cases cultures should always be taken and diphtherial antitoxin given. The respiration must be watched in case of spread to the larynx. Local treatment is as for other acute pharyngitis and tonsillitis, while large doses of antitoxin are given (4000 to 8000 units).

TUBERCULOSIS. This may attack the pharynx or palate, spreading in the form of lupus from nose or cheeks. Curetting and cauterizing with lactic acid and the use of X-rays are advised.

Apart from lupus, tuberculous ulceration usually attacks the tonsil, and is practically always secondary to pulmonary phthisis. There appears on the tonsil an indolent ulcer similar to that found on the tip of the tongue, with a considerable amount of fibroid induration about it and enlargement of the cervical glands.

Diagnosis. From cancerous ulcers diagnosis is important, as

FIG. 152.   Tuberculosis of the tonsil (magnified).

there is considerable resemblance, and while wide removal is often indicated for cancer, this course will end disastrously if practised for tuberculous ulceration. The careful examination of the lungs and sputum for evidence of tubercle, night-sweats, anæmia, and wasting will point out the condition while the ulcer is yet small. In doubtful cases, before commencing a large operation for removal of the tonsil and glands a frozen section should be taken of the ulcer, as the diagnosis of tubercle from cancer is easy under the microscope.

Treatment. In most instances painting with lactic acid, and powdering with orthoform, as palliatives, are as much as can be done, but where the condition of the lung is not severe local removal may be undertaken from inside the mouth, and this practically means enucleation of the tonsil.

SYPHILIS OF THE ORAL PHARYNX. Primary infection is rare, and usually affects the tonsil ; diagnosis may be difficult from cancer or tuberculosis.

From tubercle the absence of signs of anæmia in the lungs, and tubercle bacilli in the sputum, will help to separate; while from cancer the early great enlargement of the glands while the ulcer is quite superficial and the surrounding œdema, as well as a positive serum reaction, should distinguish.

Secondary lesions are common on the soft palate, tonsils and pharynx, taking the form of mucous patches or, as they are sometimes called, "snail-track ulcers," though ulceration is not present till later; the grey, shiny snail-tracks are formed of patches of thickened, sodden undesquamated epithelium.

In the tertiary stage gummata are common and very destructive, ulcerating rapidly, perforating the palate; if multiple a large part of the palate may melt away and be lost. Where the pharyngeal wall is affected as well the palate may become adherent to this and block the air-way from the nasopharynx, while contraction of the pharynx leads to difficulties with deglutition and respiration. The diagnosis is made on the character of the ulcers, which are punched out, often multiple, not indurated, with a yellow slough, and advancing rapidly, with little constitutional disturbance or glandular enlargement.

Treatment. This must be energetic—neosalvarsan, iodides, and mercury being employed. For the stenosis arising later, plastic operations may be necessary or gaps in the palate filled with an obturator.

RETROPHARYNGEAL ABSCESS. *Anatomy.* The posterior surface of the pharynx is separated from the prevertebral muscles by a narrow space of loose areolar tissue containing some lymph-nodes which are outlying members of the deep cervical glands, and by the prevertebral fascia which covers the front of the muscles and forms a tolerably strong membrane. Suppuration may occur in the posterior wall of the pharynx or in the tissues behind this, the term retropharyngeal being applied to all varieties. These abscesses may be acute (pyogenic) and cold (tuberculous).

(*a*) *Acute Retropharyngeal Abscesses.* These may be due to infection and suppuration of the lymphoid tissue in the back of the pharyngeal wall (akin to quinsy) or of the lymph-nodes just behind. The affection comes on acutely in small children, with high fever, difficulty in swallowing and, later, in respiration, so that laryngeal obstruction may be suspected as there is retraction of the chest-wall with inspiration and stridor, but the latter is less harsh than where the larynx is affected, nor is there the same alteration in the voice.

Diagnosis. This is made by palpating the pharynx with the finger, when a fluctuating mass in the posterior or lateral wall will be found (it is well to make this examination in all cases of respiratory difficulty before proceeding to tracheotomy, as the latter operation is seldom needed after a retropharyngeal abscess is opened). Suppuration in the wall will be in the middle line, but where originating in the retropharyngeal glands (the usual condition) more to one side of the pharynx, and there may be a swelling in the neck under the sternomastoid. If left unopened the abscess may burst into the pharynx, when there is danger of aspiration of pus into the lungs, while œdema of the larynx may follow; hence the condition is urgent.

Treatment. The abscess should be opened as soon as found ; in most instances this can be done through the mouth, gagging the latter open and inverting the patient to avoid aspiration of pus : no anæsthetic is given. Where there is doubt as to the abscess being acute or chronic, and where it presents in the neck as well as in the pharynx, it will be safer to open behind the sternomastoid as in the chronic variety, but drainage-tubes are to be

A   B
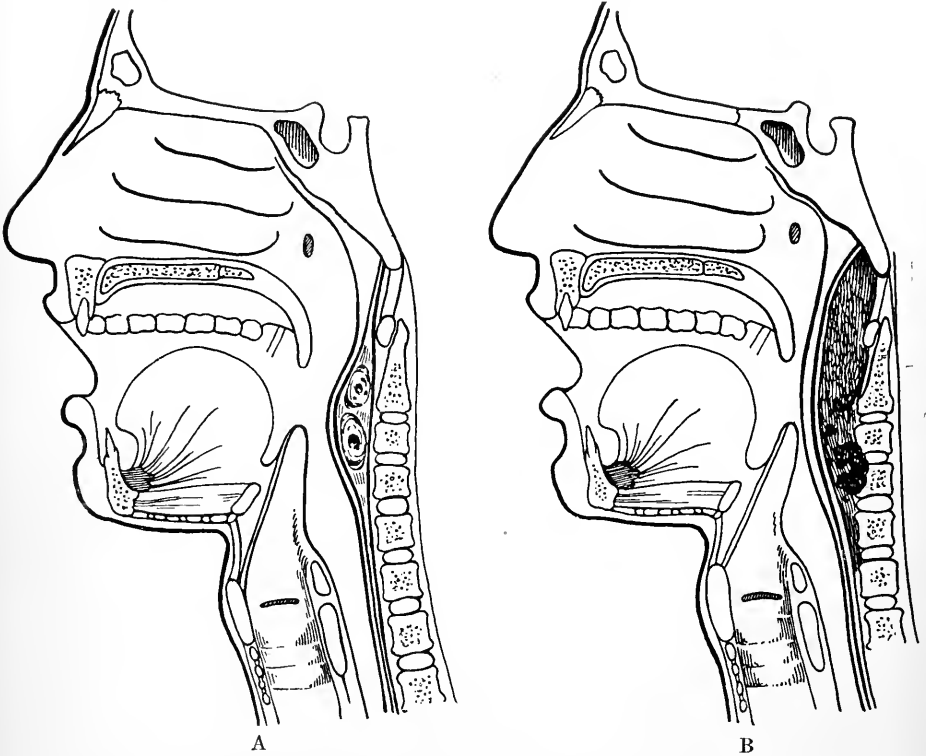
Fig. 153. A, Retropharyngeal abscess, glandular form, in front of prevertebral fascia. B, Retropharyngeal abscess due to cervical caries and lying behind the prevertebral fascia.

avoided as the incision passes just behind the carotid sheath, and a tube in a septic sinus will readily erode the carotid, with fatal result.

(b) *Chronic Retropharyngeal Abscesses.* The onset is gradual, with slight difficulty in swallowing and respiration, which is likely to be put down to tonsils and adenoids ; indeed we have known an attempt made to remove the bulging of the lateral wall of the pharynx with the guillotine, under the impression that it was an enlarged tonsil. On examination there is a smooth, fluctuating swelling bulging into the posterior and lateral wall of the pharynx, which may when large also present in the side of the neck.

These abscesses are usually the result of breaking down retropharyngeal tuberculous glands and less often result from spinal caries and abscess, the

latter tracking down under the prevertebral fascia, in which case the
swelling will be more median.

Diagnosis. This is usually easy if care be exercised ; the lateral bulging
may at first sight suggest a sarcoma of the tonsil, but further investigation
will show that the tonsil is normal and pushed aside, while the swelling
is of the posterior and lateral wall of the pharynx and fluctuates.

Treatment. Whether of vertebral (due to cervical caries) or of glan-
dular origin, the abscess should be opened by an incision behind the sterno-
mastoid, retracting the latter and the carotid-sheath forwards. The cavity
is swabbed out till clean and dry, and drained for twenty-four hours only ;
this procedure may need repetition. Where cervical caries is the cause, this
must be treated by recumbency and a jacket or splint which fixes the head.

New Growths of the Tonsils and Oral Pharynx. Innocent growths
are very rare ; fibromas and lipomas are occasionally found forming polypoid
masses, which can usually be removed without much trouble. By far the
greater number of new growths are malignant, both cancer and sarcoma being
found, the former more commonly.

(*a*) *Sarcoma* is usually of the round-celled variety (lympho-sarcoma),
occurs in young persons, and grows very rapidly. On examination the
tonsil is found enlarged, dusky-red in colour, smooth in outline, firm
on palpation, mobile at first but soon infiltrating the soft palate and causing
secondaries in the cervical glands. The diagnosis from simple hypertrophy
is made by the more rapid growth, darker colour, smooth outline, and
infiltrating properties.

Treatment. The growth should be freely removed with the deep cervical
glands where this is feasible, but it is often too adherent to the surrounding
structures ; in such cases very heavy doses of X-rays given through an
aluminium filter are worth a trial, and should also be employed after removal
of the growth.

(*b*) *Cancer* of this region is of the squamous-celled type, occurs in
middle-aged or elderly persons, and may originate on the tonsil or on the
mucosa of the palate, pharynx, or posterior part of the tongue. The growth
tends to spread to the tongue and down towards the larynx (sinus pyri-
formis) ; in some instances the soft palate is rapidly invaded, and when
originating in the lateral wall of the pharynx may spread back and become
adherent to the vertebræ. Lymphatic infection takes place early into the
deep cervical chain.

Signs. In the early stages pain on swallowing ; later, difficulty in
breathing, swallowing, and speech ; still later the mouth is opened with
difficulty and there is a fœtid discharge. As the condition is often taken
for a sore throat, the occurrence of such a complaint in persons of middle
age should lead to a careful inspection of the fauces and pharynx. When
well developed, the deep ulcer with everted edges, red indurated surround-
ings, much fixity, and foul, sloughy floor is unmistakable.

Diagnosis. In the early stages the diagnosis from tubercle and chancre
may not be easy, and has been described in a previous section (pp. 447, 448).

Treatment. Where the growth is not too adherent to its surroundings (*e.g.* the vertebræ, jaw, and base of the skull) removal with the cervical glands should be advised. When removal seems out of the question temporary improvement may be effected by means of the diathermic cautery and keeping the part as sweet as possible with irrigation. Gastrostomy and tracheotomy may be needful if life is to be maintained, and full doses of morphia close the scene.

OPERATIONS FOR MALIGNANT DISEASE OF THE TONSIL. It may be possible to remove the primary growth from inside the mouth with scissors, splitting the cheek if necessary (first performing laryngotomy and plugging the pharynx). The deep cervical glands should be removed at a second operation as for cancer of the tongue.

Where, however, there is any degree of infiltration of the base of the tumour this route will not enable the resection to be wide enough, and the operation should be performed through the neck by the method known as *lateral pharyngotomy*, removing the glands at the same operation.

Operation. The patient being in the dorsal position with the head turned to the opposite side, an incision is made along the anterior edge of the sternomastoid for its whole length and another from the middle of this to the symphysis menti. The flaps are raised and the deep cervical glands, submaxillary, salivary, and lymph glands, as well as all fat, removed from the anterior triangle, as already described under excision of the tongue. The lower part of the parotid should be removed with the rest of the glands and fat : the external carotid is tied above the superior thyroid branch and the lower part of the incision sutured. Laryngotomy is then performed and the lower pharynx packed with sponges. In most instances, to get sufficient room, the jaw should be divided in front of the masseter (first drilling holes for wiring, one on either side of the bone-section) and the posterior part retracted outwards. The posterior belly of the digastric and stylohyoid usually need division, as retraction of these seldom gives enough room. The stylopharyngeus will certainly need division and the lateral wall of the pharynx is exposed. Care is taken not to injure the hypoglossal and glossopharyngeal nerves, and the superior laryngeal branch of the vagus (the latter accident will cause anæsthesia of the larynx and increase the probabilities of aspiration-pneumonia). The pharynx is opened in front of the tonsil and, assisted by observations through the mouth, the tonsil, lateral wall of the pharynx, part of the tongue or soft palate removed wide of the growth. If necessary, half the tongue may be taken. The gap in the pharynx and buccal cavity is closed from outside as far as possible with catgut sutures, bringing the muscles into apposition : the divided muscles are sutured, the jaw wired, and the wound closed, leaving in a drainage-tube for three days. The inside of the mouth is next inspected, and the mucosa of the pharynx and buccal cavity, as well as the muscles, brought into apposition with sutures. In favourable instances the wound may be completely closed, and the more efficiently this is done the less is the risk of infection spreading down in the cellular planes of the neck.

Where the growth is very extensive and the operation correspondingly large it may be better to pack the wound with gauze, suturing the skin only in part ; healing by granulation will ultimately occur. The avoidance of oral sepsis by removal of teeth, &c., before the operation, is just as important, or more so, here than in operations on the tongue.

The patient is fed, as after tongue operations, with a feeder and rubber tube, and pharynx cleaned by irrigation with weak carbolic.

SURGERY OF THE LOWER PHARYNX

The downward extensions of the lower pharynx, viz. the œsophagus, trachea and bronchi, pass into or through the thorax, and are again considered in the section on Intrathoracic Surgery (p. 710), but as at present the greater part of the technique which can be expended on them is directed through the mouth or neck, most of the affections of these organs will be considered in the present section, partly in this, partly in the following chapter.

Anatomy. The lower pharynx extends from the top of the epiglottis to the upper opening of the œsophagus ; the front wall is almost entirely occupied by the upper opening of the larynx, which is bounded by the epiglottis, aryteno-epiglottidean folds, and the posterior part of the cricoid cartilage ; on each side of this opening is the sinus pyriformis, in which foreign bodies not infrequently lodge and where cancer fairly often takes origin. The œsophageal opening is the direct continuation of the lower pharynx, commencing at the lower border of the cricoid cartilage, opposite the sixth cervical vertebra and six inches from the teeth.

EXAMINATION OF THE LOWER PHARYNX. This includes the openings of the larynx and œsophagus, and with these are naturally considered their continuations, the trachea, bronchi, and œsophagus. There are several methods of examining these parts, each being of use under varying conditions.

(*a*) *Digital Examination.* With the forefinger the lower pharynx can be explored fairly thoroughly, especially in children ; the epiglottis is hooked up, the upper entrance to the larynx, the glottis, and sinus pyriformis palpated, and the upper orifice of the œsophagus may be reached. This method is of special value in emergencies, *e.g.* when the airway is blocked by some foreign body, which can often be removed with the finger : cancer of the sinus pyriformis can also be felt in this manner.

(*b*) *Laryngoscopic Examination.* The patient and surgeon are seated opposite to each other. The latter reflects light by means of a perforated head-mirror into the fauces of the patient ; the tongue is pulled carefully forward and the small laryngoscopic mirror set at an obtuse angle with its handle, and warmed to prevent condensation of the moisture of the breath, is pushed firmly against the soft palate till the reflected light strikes the front of the mirror. The epiglottis comes into view, and the patient is asked to breathe quietly through the mouth and then to phonate such sounds as ah, eh. The aryepiglottidean folds, the true and false cords and their movements, the posterior surface of the cricoid and the

sinus pyriformis can be inspected. In difficult cases the palate may be cocainized. If the patient be made to stand up, the surgeon being still seated, the interior of the trachea may be inspected in favourable instances and stenosis or the bifurcation of the trachea seen (Fig. 154).

(c) *Suspension or Direct Laryngoscopy* (Killian). The patient is anæsthetized in the dorsal position, the base of the tongue and pharynx cocainized and a special spatula passed down to the epiglottis; this is fastened to a
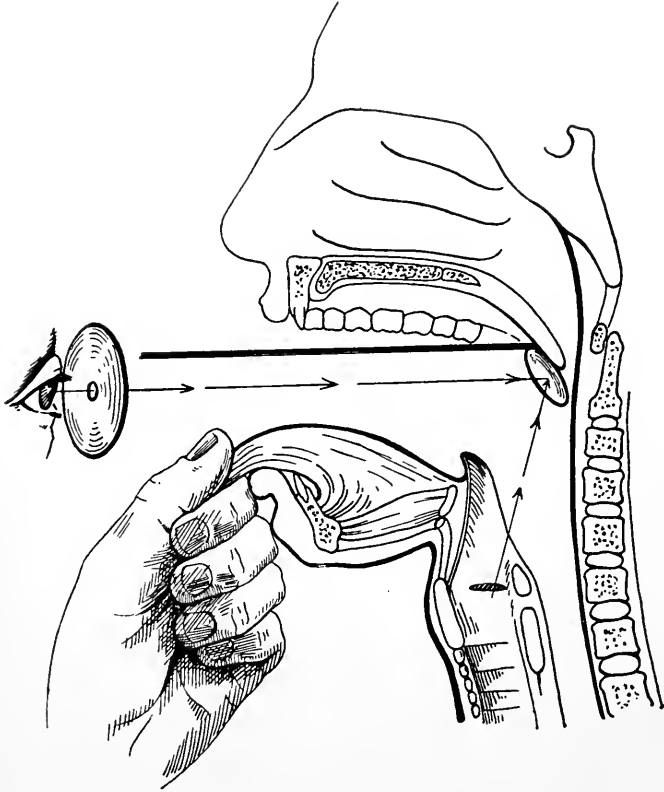
Fig. 154. Laryngoscopy.

gallows on the table; the head is allowed to fall extended over the edge of the table, being suspended by the spatula and gallows. By this means the base of the tongue and epiglottis are displaced forwards so that the upper opening of the larynx is easily seen with the head-mirror and reflected light, and a magnificent view is obtained of all the parts opening into the lower pharynx, including trachea, sinus pyriformis, upper part of the œsophagus, and these can be operated on in various ways. This method is fairly recent, but is at present the most promising method of examining and treating the lower pharynx and larynx (Fig. 155).

(d) *The Œsophagoscope and Bronchoscope* (v. Brüning). This is a most useful method of investigating the œsophagus, trachea, and larger bronchi, as well as the larynx, both for diagnosis and treatment. The instrument

consists of a tubular speculum bevelled at the end for introduction and set at right angles on its handle. Light is reflected down the tube from a lamp in the handle by a perforated mirror, through which the observer looks. An inner tube can be introduced down the speculum and the length of the latter doubled. The instrument can be introduced after cocainizing the pharynx and palate for examining the larynx and lower pharynx, but to
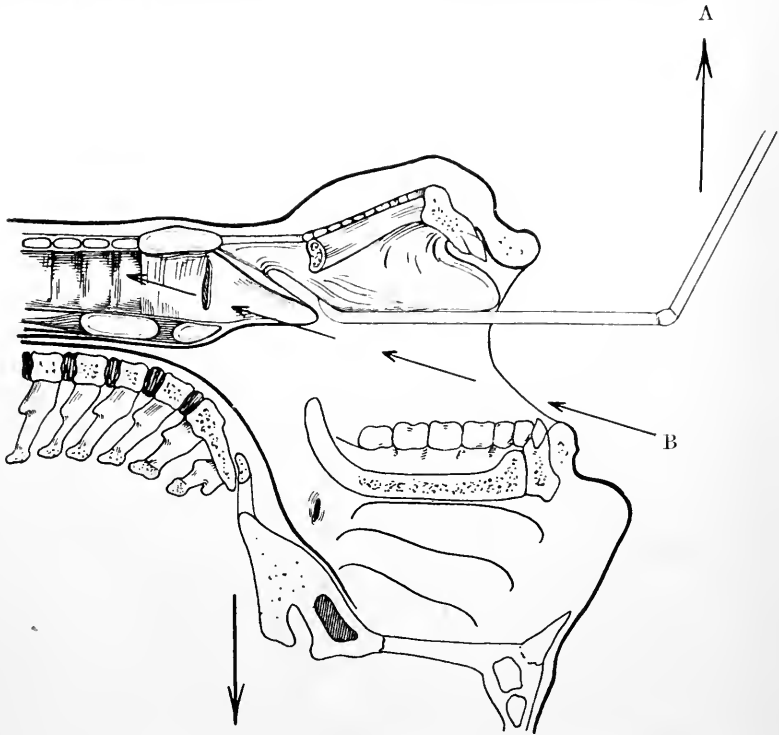
FIG. 155. Diagram of direct laryngoscopy by the suspension method (Killian). A, Special spatula which holds up the jaw and tongue, and is slung from a gallows above the point A. B, Line of vision.

examine the œsophagus, trachea, or bronchi a general anæsthetic in addition is generally advisable, as follows :

The patient having been injected with $\frac{1}{100}$ grain of atropin to diminish bronchial secretion, is anæsthetized in the dorsal position and the pharynx cocainized (10 per cent. cocain), the tongue pulled forward with a suture, and the instrument introduced. The head is thoroughly extended over the end of the table and the instrument passed down under guidance of vision. The base of the tongue and epiglottis are first seen, and by extending the head very thoroughly and pointing the end of the instrument forward (the handle backward) the entrance to the larynx can be seen. The glottis is then cocainized and a short pause made ; when the glottis is insensitive, so that no spasm occurs, the instrument is passed through this into the trachea, and if this be normal, down towards the bronchi. The inner tube is then inserted and pushed down into the bronchi in turn. A good view

of the latter is obtained, the apertures of the larger bronchioles being seen, and any foreign body which may be present is removed with suitable forceps. Having once entered the trachea, the instrument needs much less tilting than is needed to effect an entry.

To enter the œsophagus the instrument is passed straight downwards after clearing the epiglottis, working the distal end over to the left and inserting the inner tube, going gradually down till a stricture or foreign body is seen. Owing to the pulpy state of the mucosa of the trachea, bronchi and œsophagus (especially where a foreign body has set up irritation), and the movement of respiration, small objects, e.g. pins, tacks, coins, may be
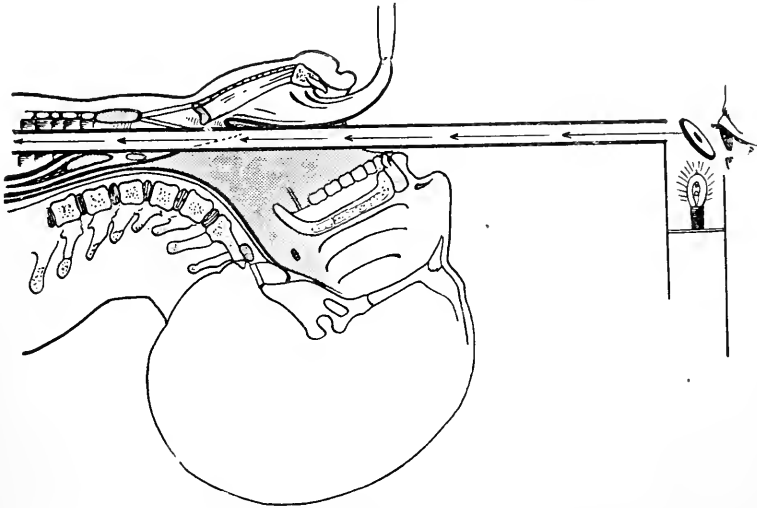
Fig. 156.   Inspection of the trachea with a bronchoscope.

hard to see. Thus a ten-shilling piece in the right bronchus was only seen after entering the bronchus three times, apparently being brought into view by a cough. Larger objects, such as tooth-plates, large coins, are easily seen, and once seen, extraction is usually easy unless embedded in the wall. Strictures of the œsophagus may be seen and their mobility tested with a view to removal.

(e) The gum-elastic bougie is useful for ascertaining the position of a stricture of the œsophagus. A fairly large size (18) should be used : after softening in warm water it is passed on the seated patient, who must not extend the head but should try to swallow the bougie. Sudden and complete stoppage of the instrument in its course usually implies a stenosis, which in most cases is of cancerous nature. The distance which the bougie has passed from the teeth is then measured. The following lengths are worth remembering : six inches reaches to the cricoid or upper opening of the œsophagus, eleven inches to the bifurcation of the trachea, and sixteen to the cardiac orifice of the stomach, so that if a bougie pass seventeen inches we can be fairly certain that it has reached the stomach.

Note. Before passing any instrument into the œsophagus care is taken to exclude intrathoracic aneurysm : inequality of the pulses, dullness, abnormal pulsation and bruits in the chest, laryngeal paralysis, and tracheal tugging will point to such a cause of œsophageal obstruction, and a radiogram will confirm.

(*f*) Radiograms are of great service in revealing the presence (if opaque) of foreign bodies in the œsophagus, trachea, or bronchi ; the fluorescent screen is even more useful. Stenosis of the œsophagus can also be tested in this manner by screening after administration of a meal containing bismuth. The lower limits of the opaque bismuth and the bulging of the œsophagus at this point will denote the position of the stricture.

SURGERY OF THE ŒSOPHAGUS

Anatomy. The œsophagus is a tube ten inches long with an inner lining of mucosa and an outer covering of muscle, but, unfortunately for surgical interference, unlike most of the alimentary tract, possesses no peritoneal covering. This tube extends from the cricoid at the sixth cervical vertebra to the cardiac orifice of the stomach at the eleventh dorsal. The upper end, then, is six, the lower sixteen inches from the teeth, and it is crossed in the thorax about ten to eleven inches from the teeth by the left bronchus. At the three points mentioned the calibre is slightly narrowed, and these are the places where cancer elects to start.

The walls of the cervical portion are collapsed together, while the thoracic portion is kept open by the negative pressure of the thorax ; the lower end, again, is closed by the cardiac sphincter of the stomach and its passage through the diaphragm. In the neck it is related to the trachea in front, the prevertebral muscles behind, while the carotids, recurrent laryngeal nerves, and lateral lobes of the thyroid are on either side. In the thorax the trachea, left bronchus, pericardium, heart, and diaphragm are in front ; behind are the vertebræ above, the aorta below ; on the right side is the thoracic duct, and below the right pleura ; the left pleura is a relation on the left side below, the aorta above.

Congenital Defects. Communication with the trachea and complete stenosis of the tube are recorded, but are hardly compatible with life. Minor degrees of stenosis of congenital origin may be in part responsible for pouches and dilatations of the œsophagus, and are described under that heading.

Injuries of the Œsophagus. The œsophagus may be lacerated or ruptured in various ways : swallowing or attempting to swallow hard, rough, or sharp objects ; swallowing corrosive fluids ; violent removal of impacted bodies, especially where the organ is already softened by inflammation around the object ; vomiting after heavy meals, especially in alcoholic subjects.

Signs. These are, pain deferred to the cervical and thoracic region, shock, difficulty of swallowing, and vomiting of blood. Where the laceration extends to the mediastinum or pleura it may be complicated by wounds

of the pericardium, heart, aorta, pleura, &c., and lead to mediastinitis, empyema, &c., when the prognosis is very grave.

Treatment. It is generally advised to avoid feeding by mouth for several days, relying on rectal alimentation and watching the chest carefully for signs of empyema or mediastinitis or cellulitis of the neck, and draining these as they arise. Since the invention of the œsophagoscope it should be worth while investigating doubtful cases with this instrument, and if a large rent be found in the œsophagus, to explore it through the neck or through the thorax (under positive pressure and a long intercostal incision, p. 710), suturing if possible and certainly draining the site of rupture. The difficulty in such examination is to be certain that the wound actually penetrates the œsophagus.

INJURIES FROM SWALLOWING CORROSIVE FLUIDS. The result of swallowing sulphuric or hydrochloric acid, caustic potash, boiling water, &c., vary with the strength of the solution and the amount taken. Boiling water (*e.g.* a child drinking from the spout of a kettle) seldom penetrates further than the lower pharynx, and is a well-known cause of severe œdema of the larynx in infants. Caustics fluid may only affect the mucosa or swiftly char through muscles as well. The action is most marked at the upper and lower ends of the tube—the middle part, especially the open portion in the thorax, often escaping. Where the lesion is perforative, suppuration in the neck or mediastinum will naturally follow. The early signs are great pain, thirst, vomiting of small amounts of blood-stained fluid containing charred mucosa and debris. Œdema of the larynx is not uncommon and dyspnœa may be urgent.

Treatment. For the immediate effects an attempt is made to neutralize the caustic, giving chalk or magnesia where acids have been imbibed but weak vinegar if the material were caustic alkali. These are given alternately with mucilage. Emetics are strictly avoided as likely to cause rupture of the weakened tube ; morphia and transfusion for shock are indicated, and later rectal feeding of saline and nutrient enemas or gastrostomy. Watch is kept for suppuration in the cervical region or mediastinum, and abscesses opened as they form.

The later results, viz. stenosis of the œsophagus and its treatment, are described later under Stenosis (p. 459).

FOREIGN BODIES IN THE ŒSOPHAGUS. All manner of objects may be swallowed accidentally or on purpose and stick in the œsophagus. Coins in children and dentures in adults are the most usual. Surprisingly large, long objects can pass down into the stomach without being impacted, as table-forks, spoons, knives, swords, &c., but practice is usually needed for such facility.

Results. When impacted in the lower pharynx or upper end of the œsophagus there is some danger of the laryngeal opening being blocked and death from suffocation rapidly occurring unless the object is removed. Where not large enough to block the larynx the irritation may cause œdema of the latter and equally severe dyspnœa. In the œsophagus there may be

little discomfort or swallowing may be impossible. Smooth objects, such as coins, may remain in the œsophagus several days without causing any harm, but sharp bodies, such as pins, hooked dentures, &c., will surely cause ulceration and later perforation, resulting in cellulitis of the neck or mediastinitis.

Diagnosis is made by the history, and if opaque by the fluorescent screen ; when the body is not opaque the œsophagoscope should be passed : should the object be impacted in the lower pharynx urgent dyspnœa will often call attention to the trouble.

Treatment. In urgent cases, where the foreign body is impacted in the lower pharynx at the opening of the œsophagus and there is urgent dyspnœa, a finger should be passed down the pharynx past the epiglottis, and often the foreign body can be hooked out. Where this fails and dyspnœa is urgent, laryngotomy should be done with any available knife, thrusting this through the cricothyroid membrane in the middle line. When the urgent signs are relieved we may investigate the obstruction in an orderly manner with laryngoscope or œsophagoscope. If the object is smooth or flat, as in the case of coins, it may sometimes be recovered by fishing with œsophageal forceps ; more success, however, attends the use of the *coin-catcher*, which as a rule brings out coins with speed and safety. As, however, accidents have occurred with this instrument, either from its breaking off or from the object becoming twisted during extraction, so that excessive force is used and the œsophagus is torn, the use of the *œsophagoscope* is advised in all cases, for since the object is in view all the time, the grip on it can be altered and regulated so that the minimum damage is done to the œsophagus. Where the body is irregular, such as a denture, and firmly impacted, the œsophagoscope is the only instrument admissible through the mouth, and several attempts should be made to loosen the impacted object. When, after several attempts, the foreign body cannot be extracted thus it must be removed from outside the œsophagus, or it will certainly ulcerate through, probably with fatal results.

(*a*) When the seat of impaction is the upper part of the œsophagus, the latter is opened in the neck (cervical œsophagotomy). A four-inch incision is made along the anterior border of the left sternomastoid. This muscle is retracted outward, the trachea, thyroid-gland, and carotid sheath pulled inwards, exposing the œsophagus ; the latter can be followed some distance into the thorax, opened over the impacted body, and the latter removed ; the œsophagus is then sutured and the posterior mediastinum drained for four days. The food should be liquid for ten days. (*b*) When the impaction is in the thoracic œsophagus it should be removed by a long intercostal incision under positive pressure-anæsthesia, opening the œsophagus and suturing again, and draining pleura and mediastinum ; it is better to operate while the tissues are comparatively clean than to wait till mediastinal abscesses empyemas, &c., are present.

The horse-hair probang is to be avoided in the removal of foreign bodies, as it may stick in any irregularities of the latter, causing great trouble.

INFLAMMATIONS OF THE ŒSOPHAGUS. Acute œsophagitis may follow on pharyngitis, by downward spread of the latter. The signs are exquisite pain on swallowing, so that even swallowing of saliva is avoided ; this, fortunately, passes off rapidly. Sucking ice may relieve or injection of morphia be needed.

Tuberculosis is uncommon, but may result by spread from bronchial glands or retropharyngeal abscess.

Syphilitic ulceration sometimes occurs, leading to stricture later. In both these last conditions there is pain on swallowing and regurgitation of food, which is stained with blood.

STENOSIS, OR STRICTURE OF THE ŒSOPHAGUS. Stenosis may be spasmodic or organic.

SPASMODIC STENOSIS OF THE ŒSOPHAGUS. Two forms of this affection are recognized : (a) the *hysterical* form and (b) the condition known as *cardiospasm*.

(a) *Hysterical Spasm.* This is found in young nervous women associated with the feeling of a ball rising in the throat (globus hystericus). Some slight abrasion causing pain, may be the origin or it may arise spontaneously. The condition is to be distinguished from organic stricture by the fact that it is not always present and does not develop slowly but arises suddenly, while the youth and sex of the patient will be suggestive.

As in other hysterical affections, treatment is often difficult. We must persuade the patient that there is nothing the matter and that swallowing is quite possible ; hence the less attention there is paid to the œsophagus the better, though in some cases the passage of a full-sized bougie may have a good effect. General tonics, valerian, massage, and outdoor exercise are indicated.

(b) *Cardiospasm.* In this affection there is a spasm of the cardiac orifice of the stomach with dilatation of the œsophagus above, which has been described as " idiopathic dilatation of the gullet."

Signs. Difficulty in swallowing and, later, regurgitation of food from the dilated œsophagus. As this dilatation increases the period at which regurgitation takes place after meals becomes increased. There is a sense of oppression in the thorax. The condition usually affects middle-aged persons. The dilatation of the œsophagus above the contracted cardiac orifice is seen with the fluorescent screen after a bismuth meal. Examination with the œsophagoscope completes the diagnosis.

Treatment. The contracted cardia must be dilated by passing bougies down with the aid of the œsophagoscope. If this fails a thread should be swallowed, which will ultimately pass the cardiac orifice, and when some yards have been swallowed a hollow bougie is passed over the thread and so dilatation begun. The cardiac orifice may also be dilated from below, opening the stomach through a laparotomy. After thorough dilatation the spasm will usually subside.

ORGANIC STRICTURE OF THE ŒSOPHAGUS. This may be (a) simple, fibrous or cicatricial, and (b) the result of malignant growth.

(*a*) *Fibrous Stricture.* This most usually results from swallowing corrosive fluids, seldom after drinking boiling water, as the latter is rejected from the pharynx ; contraction of syphilitic ulcers and infiltrations accounts for some examples. This form of stenosis occurs mostly at either end of the gullet, where the action of corrosives is greatest, and is decidedly less common than malignant stricture.

Signs. There is a gradually increasing difficulty of swallowing, first of solids, then of fluids ; regurgitation of food comes on as the œsophagus dilates above the stricture and is often described as " vomiting " : when the stricture is low down this may occur at some little interval after taking food, but is distinguished from true vomiting by the fact that the food is quite unaltered by digestion. As the condition becomes worse the patient gradually wastes and, unless relieved, dies of starvation.

Diagnosis. Investigation with bougies, commencing with large and passing to smaller sizes, will give the position and calibre of the stricture, while investigation with X-rays and the œsophagoscope may be of assistance. The distinction from malignant stricture is usually easy, from the history of the patient having swallowed corrosive fluid, and is most common in young women (who prefer this method of attempting suicide), while cancerous stricture usually is found in old men.

Treatment. Where the patient is already much emaciated it may be well to perform a gastrostomy so as to improve the general condition and rest the gullet ; after a week or so treatment with bougies may be commenced. Where the condition is less aggravated the stricture may be dilated with bougies, passing a larger size every third day till it is fully dilated, after which bougies should be passed every fourteen days and then every month for a long period to prevent re-contraction. Where there is difficulty in dilatation owing to the toughness of the stricture Symonds's tubes (p. 461) may be inserted and left in for two or three days, being replaced with larger sizes till full dilatation is secured. Strictures of the lower portion may be dilated manually from the stomach. Where the opening in the stricture is very small the " string-saw method " of Abbé may be employed. The first thing is to get a silk thread through the aperture. This may be done by passing fine bougies up from the stomach and out of the mouth, to which strong silk thread is attached, or by daily swallowing a portion of a long, fine silk thread (the bulk of which is wound round the ear) till several yards have been ingested and it is fairly certain that the end is in the stomach. The stomach is then opened, a stronger thread tied to the fine one in the stomach, and this pulled out of the mouth. The strong silk is then used as a saw, pulling either way in turn ; the stricture is thus divided and bougies passed regularly afterwards, or a piece of stout rubber-tube pulled into the stricture and left for a few days. Should these methods fail after repeated attempts, it will be necessary to put up with a permanent gastrostomy. Where there is any suspicion of the stricture being syphilitic, treatment for this is indicated.

(b) *Malignant Stricture of the Œsophagus.* This practically always takes the form of squamous-celled cancer, and usually causes stenosis, which is the main indication of its presence. Malignant stricture of the œsophagus is essentially a disease of old age, being uncommon under fifty and usually found over sixty.

This form of stricture occurs at the ends of the œsophagus and at the crossing of the left bronchus in the following proportions (Janeway and Green) : the upper end 15 per cent., the bifurcation of the trachea 32 per cent., the cardiac orifice 52 per cent. The spread of cancer is into surrounding structures, mediastinum, lungs, and into the deep cervical and mediastinal glands. Ulceration may take place into the trachea, causing pneumonia, or into the mediastinum, causing mediastinitis and empyema, but the more urgent signs are from œsophageal obstruction and the resulting gradual starvation.

Signs. These are as in fibrous stricture, viz. increasing difficulty in taking first solid, then liquid food. The appearance in advanced cases is characteristic, the general emaciation being great, and the wasted abdomen is retracted so that the anterior wall of the latter falls straight back from the thorax to the posterior abdominal wall. The œsophagus may become pouched above the stricture, causing " pseudo-vomiting."

Diagnosis. This is made with bougies, bismuth meals and X-ray screening, and the œsophagoscope. From stenosis following swallowed corrosives, the history and age at once separate this condition ; from syphilis the earlier age in the latter condition and the serum reaction is suggestive, but the diagnosis of syphilitic stricture is difficult, and amelioration following anti-syphilitic treatment is not absolute proof of the syphilitic nature of the condition.

Treatment. In many instances the most satisfactory plan is to perform gastrostomy by Kader's or Witzel's method as soon as there is any difficulty experienced in swallowing liquids and before emaciation is great (many cases are brought up for surgical treatment far too late, and hence this simple operation carries too high a mortality).

Removal of the growth and the part of the œsophagus containing it is one of the problems of surgery at present. It is most likely to be successful at the upper and lower ends, in the former case being done through an incision like that for œsophagostomy but larger, the ends being sutured off and a gastrostomy done ; or the part removed may be replaced by in-turned flaps of skin or small intestine. The lower end is a more suitable place, and more cases of cancer are found here. The growth should be removed by transthoracic incision (*see* Intrathoracic Surgery) and the stomach pulled up and anastomosed to the stump or a loop of small intestine employed to form an anastomosis. The technical difficulties of these operations render them only occasionally available for patients of declining years.

Palliative Measures. Dilatation is inadvisable as being likely to increase the ulceration and danger of perforation into surrounding cavities. Intubation with Symonds's tube is sometimes satisfactory. This is a tube six

inches long of gum-elastic, the upper end being enlarged and funnel-shaped to prevent its slipping through the stricture. This is introduced through the stricture with a special flexible introducer. From the upper end a silk thread passes up the gullet and is tied to the ear, so that the tube may be withdrawn every two or three weeks in order to be cleaned. There is some danger of increasing the ulceration and causing perforation, and this plan should only be employed where the patient is very adverse to gastrostomy.

FIG. 157. Pharyngocœle. Diagrammatic section through the pharynx showing the sac lying behind the cricoid.

DILATATIONS AND POUCHES OF THE PHARYNX AND ŒSOPHAGUS. As mentioned, dilatation of the œsophagus takes place above fibrous and malignant strictures and spasm of the cardiac orifice. The diagnosis and treatment have been discussed in treating of these subjects.

Pouches and Diverticula. The usual variety (pharyngocœle) is situated on the posterior wall opposite the cricoid cartilage, at the junction of the pharynx and gullet. The condition appears to be due to pressure from within (*pressure-diverticulum*) acting in a tube the walls of which are weak from congenital or acquired defects (partial stenosis of the entrance of the œsophagus and deficient muscular wall). These pouches are uncommon before forty years of age.

Signs. Increasing difficulty of deglutition, continuing for years and progressing slowly (much more slowly than when due to stricture). As the pouch increases in size there will follow regurgitation of undigested, partly putrefied food at varying intervals after meals. Later the pouch interferes greatly with swallowing and emaciation results, ending in death from starvation.

A swelling may be noted in the lower part of the neck, varying in size from time to time, and pressure on this may cause eructation of gas or regurgitation of food. A bougie may be at one time completely stopped about nine inches from the teeth or at another trial pass right into the stomach, according as it hits or misses the mouth of the sac. Examination with the fluorescent screen after a bismuth meal shows the sac filled with bismuth, while the opening may be seen with the œsophagoscope.

Treatment. As the condition either passes on into complete œsophageal obstruction, or ulceration and perforation lead to severe infections of the neck and mediastinum, operative measures are indicated as soon as the diagnosis is made.

Operation. The pouch and œsophagus are exposed by incision along the left sternomastoid as for œsophagostomy, and the thyroid, trachea, and carotid sheath displaced forwards. A curved metal bougie introduced into the pouch from the mouth is useful to define its limits. The sac is well defined by dissection and then dealt with, either by removing it and suturing the aperture left with two or three layers of interrupted sutures, or the sac may be invaginated into the œsophagus and retained by sutures at its mouth (Girard). Good results are claimed by both methods, but excision is more often performed and with success. The wound in the neck should be drained, as leakage and suppuration are likely to follow for a short time. A preliminary gastrostomy and feeding up for a few days before the main operation is indicated where the patient has been long starved. After operation feeding should be per rectum for five days or *via* the gastrostomy aperture.

Traction diverticula occur at the middle reaches of the œsophagus, due to the contraction of caseating bronchial glands. They are small and seem to be of little more than pathological interest.

CHAPTER XXXI

SURGERY OF THE LARYNX, TRACHEA, BRONCHI, NECK, AND THYROID GLAND

Anatomy of the Larynx : Foreign Bodies in the Larynx, Trachea, and Bronchi : Injuries of the Larynx : Acute Infections of the Larynx : Diphtheria : Acute Œdema of the Larynx : Chronic Laryngitis : Syphilis of the Larynx : Tuberculosis of the Larynx : Perichondritis : New Growths of the Larynx, Benign, Malignant : Stenosis of the Trachea : Nervous Affections of the Larynx : Laryngotomy : Tracheotomy : Intubation of the Larynx : Median Pharyngotomy : Lateral Transthyroid Pharyngotomy : Median Thyrotomy : Laryngectomy : Anatomy of the Neck : Injuries of the Neck : Cut Throat : Cellulitis of the Neck : Actinomycosis, Tumours and Cysts of the Neck : The Thymus : Anatomy of the Thyroid Gland : Thyroiditis : Simple Goitre : Operation for Goitre : Malignant Goitre : Exophthalmic Goitre.

Anatomy of the Larynx. The upper orifice of the larynx is formed by the epiglottis, aryepiglottidean folds, and the posterior part of the cricoid, and is directed backwards into the lower pharynx. The mucosa covering it is loose and readily becomes œdematous, blocking the laryngeal aperture, especially in small children. The true vocal cords, which are the upper edges of the cricothyroid ligaments, are closely covered with mucosa, and are separated (abducted) by the posterior crico-arytenoid muscles, approximated (adducted) by the interarytenoid and lateral crico-arytenoid muscles, and stretched by the cricothyroid muscle. The true vocal cords are lower than the false cords and closer together, being separated from the latter by the sinus of the

Fig. 158. The larynx as seen with the laryngoscope. *a*, Epiglottis. *b*, Vocal cord separated by the sinus (dark) from (*c*), the false cord. *d*, The sinus pyriformis.

larynx. The lower larynx is below the vocal cords, extending to the lower border of the cricoid cartilage. The mucosa of this part is also loose and liable to become œdematous, and is continuous with the loose mucosa of the trachea and bronchi, but is less likely to cause trouble from this reason except in small children, in whom œdema is a serious matter owing to the small calibre of the tube.

Examination of the larynx is described in the preceding chapter with that of the lower pharynx (pp. 452–456).

FOREIGN BODIES IN THE LARYNX, TRACHEA, AND BRONCHI. Mention has been made in the last chapter of the impaction of foreign bodies in the

lower pharynx and upper opening of the larynx, and of the urgent symptoms which may arise. Small objects, such as buttons, collar-studs, coins, pins, tacks, &c., may lodge in the sinus pyriformis, between the cords, in the laryngeal sinus, or pass down into the trachea and bronchi. Owing to the more straight direction of the right bronchus and since the point of bifurcation of the trachea is more to the left, such objects, if too small to remain in the trachea, usually pass into the right bronchus.

When impacted in the *larynx* there will be immediate and severe symptoms of choking and dyspnœa, going on to complete obstruction of the larynx if the body be large or if much spasm of the laryngeal muscles takes place. Where the body is smaller the violent spasms of coughing and choking will pass off, leaving some dyspnœa and alteration in the voice. In a few hours œdema of the larynx will commence and dyspnœa become increasingly urgent, though this is less in the large larynx of adults than in the small one of children. In some instances in adults, ulceration and perichondritis may occur without dyspnœa becoming very great.

Where the body passes into the *trachea* and bronchus the urgent signs pass off or may not occur if the body be small, and the patient may think that the latter has been swallowed. When in the trachea little irritation results at first, but later ulceration and abscess-formation may result or the object may be coughed up into the larynx, causing choking.

When the foreign body passes into the *bronchus* it may plug the latter tightly, when collapse of the lung on that side will result, or ulceration through the bronchial wall will lead to pulmonary abscess, empyema, &c. The time for such events to result varies greatly : in some instances only a few days, in others some months, elapse before severe symptoms arise, but these seldom fail to appear in time ; hence the need for extracting such foreign bodies early.

Diagnosis. Opaque objects may be located with X-rays and the screen ; failing this, if there is good reason to suspect the presence of such a body, examination of the trachea should be made with the bronchoscope, and each bronchus in turn is carefully examined, since early extraction will probably save the patient's life.

Treatment. When impacted in the larynx, preparation should be made for tracheotomy, which may become urgent at any moment ; in adults the pharynx is cocainized and examination made with the laryngoscope, when it may be possible to extract the body with curved laryngeal forceps. Where the object is firmly impacted, and in children in all cases, the bronchoscope will be more useful, employed under general anæsthesia and cocainizing of the larynx. Where the apparatus for direct suspension laryngoscopy is to hand this is the method of preference for removing objects from the larynx, lower pharynx, and sometimes from the trachea or upper part of the œsophagus (unfortunately, this excellent instrument is rather large to carry about for emergencies, while the bronchoscope is eminently portable).

When the object is firmly impacted in the larynx and cannot be pulled out (which is unusual) it will be necessary to open the larynx (thyrotomy)

by splitting the thyroid cartilage vertically in front, though in some instances it may be possible to push the impacted substance up from a tracheotomy wound.

In all cases where there is urgent dyspnœa tracheotomy should be done at once if extraction with the finger fail.

From the bronchi, extraction is not very difficult if the object can be seen, but the folds of mucosa are larger than might be thought, and, as we have mentioned, on one occasion so large an object as a ten-shilling piece escaped notice for some little while until brought into view by a convenient cough.

The bronchoscope may also be passed through a tracheotomy wound.

Finally, it should be noted that it is not always easy to tell from radiographic examination whether the foreign body is in the œsophagus or bronchus, and where it cannot be found in one the other should be searched.

INJURIES OF THE LARYNX. (a) *Subcutaneous.* These result from blows and crushes (garrotting) : the skeletal structures may be fractured, viz. the hyoid or thyroid.

Signs. In either case there will be pain on swallowing, moving the jaw and tongue ; the voice will be hoarse, and dyspnœa may be present and become urgent if much œdema of the larynx or submucous bleeding take place. If the fragments penetrate the mucosa blood-stained expectoration will be a marked symptom. In fracture of either bone or cartilage, displacement may be felt on palpation of the neck and crepitus noted.

Treatment. The main danger to be feared is from œdema of the larynx, and preparation should be made to perform tracheotomy at a moment's notice if dyspnœa becomes marked. Otherwise the patient should rest in bed, on soft or liquid diet for a few days, till the pain is relieved and there is no more fear of œdema of the larynx, the fracture being partly united.

(b) Wounds of the larynx are usually from outside, especially in cases of " cut throat." The treatment consists in suturing the divided parts, and possibly a palliative tracheotomy (*see* Injuries of the Neck, p. 483).

INFLAMMATIONS AND INFECTIONS OF THE LARYNX. *Acute Infections.* These are common and due to organisms of the pneumococcus and streptococcus groups, B. catarrhalis, B. influenzæ, &c., and often occur in conjunction with coryza, pharyngitis, acute tonsillitis, &c., in children as complications of measles, scarlet fever, &c.

Signs. Hoarseness, pain on phonation and deglutition are noted ; with the laryngoscope redness of the larynx and cords is plainly seen. In children, owing to the small size of the laryngeal opening, the congestion may lead to inspiratory dyspnœa.

Treatment. (a) In adults the condition is seldom severe, and soon yields to confinement to the house, completely resting the voice (whispering only), and inhaling the vapour of hot water which contains a dram of tincture of benzoin or the same quantity of turpentine, while spraying the throat with menthol and eucalyptus in parolein gives much relief. Cold

liquid diet is advisable. Severe dyspnœa necessitating tracheotomy is rare in adults.

Where attacks of laryngitis are frequent the nose and nasopharynx should be carefully examined and spurs, deviated septa, rhinitis. pharyngitis treated, or chronic laryngitis will result.

(*b*) In children, owing to the small calibre of the larynx and the greater amount of œdema of the mucosa usually present, dyspnœa may become urgent, especially in cases accompanying measles or scarlet fever. In such cases tracheotomy may fairly often be needed, and the practitioner should always be prepared for this necessity in cases of laryngitis in young children.

LARYNGEAL DIPHTHERIA ; CROUP. This may arise in sequence to faucial diphtheria, in which case the diagnosis is relatively easy, as the signs of acute laryngitis are superimposed on those of the former condition, the false membrane spreading to the larynx and glottis.

In other instances the affection starts with formation of false membrane in the larynx, and the diagnosis from other forms of laryngitis with obstruction is not easy to make, as the larynx of small children is hard to examine. In such cases, if severe, tracheotomy or intubation is indicated, and in any case a culture should be taken from the larynx to settle the diagnosis, and when in doubt a prophylactic dose of antidiphtherial serum should be given before the diagnosis is settled to save time, which may be very valuable at this stage.

ACUTE ŒDEMA OF THE LARYNX. This is one of the most important causes of laryngeal obstruction and is due to various causes :

(*a*) Injury, whether laceration or gross wounds such as " cut-throat," or irritation of some small foreign body, *e.g.* a fish-bone impacted in the larynx, the swallowing of boiling water in children or corrosive fluids in older patients.

(*b*) The result of acute inflammations of the larynx (usually in children).

(*c*) By spread from surrounding parts, as the tongue, mouth, submaxillary region (Ludwig's angina).

(*d*) By lighting up of acute inflammation in the course of some chronic disease such as tubercle, syphilis, cancer : in such cases it is mostly found when the cartilage is invaded, *i.e.* when *perichondritis* is present.

(*e*) In chronic renal (Bright's) disease, in which the œdema of other parts is so common, œdema of the larynx occasionally results.

Anatomy. The œdema affects chiefly the epiglottis, aryepiglottidean folds, and the false cords, the former swelling up and becoming like pillows, while the epiglottis is folded on itself (turban-shaped), producing obstruction above the glottis ; while in some instances the subglottic tissues are also œdematous.

Signs. There is hoarseness, alteration of the voice, and pain of swallowing, and as the condition increases the patient feels as if the throat were filled with a foreign body ; respiration becomes more difficult, and is finally accomplished with stridulous noise ; in-drawing of the thoracic wall on inspiration is marked in children, while the colour of the face alters from

red to purple and then to blue or grey as asphyxia advances. The œdematous epiglottis and aryepiglottidean folds can be seen with the laryngoscope, or in children felt with the finger.

Treatment. In most instances where the condition is well marked tracheotomy is urgently needed and should be performed, though in the early stages multiple punctures of the œdematous parts and inhalation of water-vapour may relieve the affection.

CHRONIC INFLAMMATIONS OF THE LARYNX. (*a*) *Chronic Simple Laryngitis.* This is often the sequel of chronic infections and other diseases of the nose and nasopharynx, whereby nasal respiration is impeded. Dusty atmosphere, the abuse of tobacco and alcohol, prolonged and strained use of the voice in loud speaking or singing, account for many cases.

Signs. There may be pain on phonation and deglutition ; more often the chief complaint is that the voice is hoarse and husky and is apt to be lost after using it for some time. There is often excessive secretion of muco-pus, which is hawked up. On examination the cords are seen to be thickened and to have lost their clear outline and grey colour, being dirty white or reddish in colour, and mucus will be seen sticking to them, while the rest of the larynx and pharynx is congested and shows dilated venules.

In old standing instances the condition of " pachydermia laryngis " may be found, the epithelium being thickened over part or all of the cords, forming white hypertrophic patches resembling leucoplakia of the tongue, and, as in that condition, being sometimes the precursor of cancer.

Another condition is that of " singer's nodes," which are localized thickening of the cords with hypertrophy of the epithelium over them.

Treatment. Attention to the nasopharyngeal condition is of prime importance ; spurs and deviations of the septum should be corrected, suppurative foci and adenoids removed. The voice should be thoroughly rested, speech being forbidden : smoky, dry, and dusty atmospheres should be avoided, and sedative inhalations and sprays will cure in the earlier stages. When the condition is more advanced or does not yield to such methods astringents should be employed, such as silver nitrate solution (1 to 3 per cent.) painted on the larynx after first cocainizing the latter. Where pachydermia or singer's nodes do not yield to such measures after fair trial the hypertrophic part should be excised with intralaryngeal punch-forceps, and in the latter condition the part removed examined microscopically lest it prove to be cancerous.

(*b*) *Syphilis of the Larynx.* In the secondary stage mucous patches are found causing signs of subacute laryngitis and being visible as grey patches on examination with the laryngoscope. The treatment is specific for generalized syphilis. In the tertiary stage gummata occur in the epiglottis, aryepiglottidean folds, and interior of the larynx ; ulceration is common, the ulcers having the characteristic appearance of tertiary ulcers, being punched out with hyperæmic surroundings, a yellow, sloughy floor and absence of glandular enlargement. Where these ulcers spread rapidly perichondritis results, which is later followed by cicatricial contraction and

stenosis of the larynx in severe or neglected cases. The usual signs are hoarseness and dyspnœa, laryngeal obstruction being common, while dysphagia is much less usual than in tuberculous ulceration : on examination the ulcers and infiltrations are seen (Fig. 159).

Diagnosis from tuberculous ulcers is made by the well-defined edge of the ulcer and surrounding redness, contrasting with the gnawed edge and surrounding pallor or tubercle, by the epiglottis being especially affected,
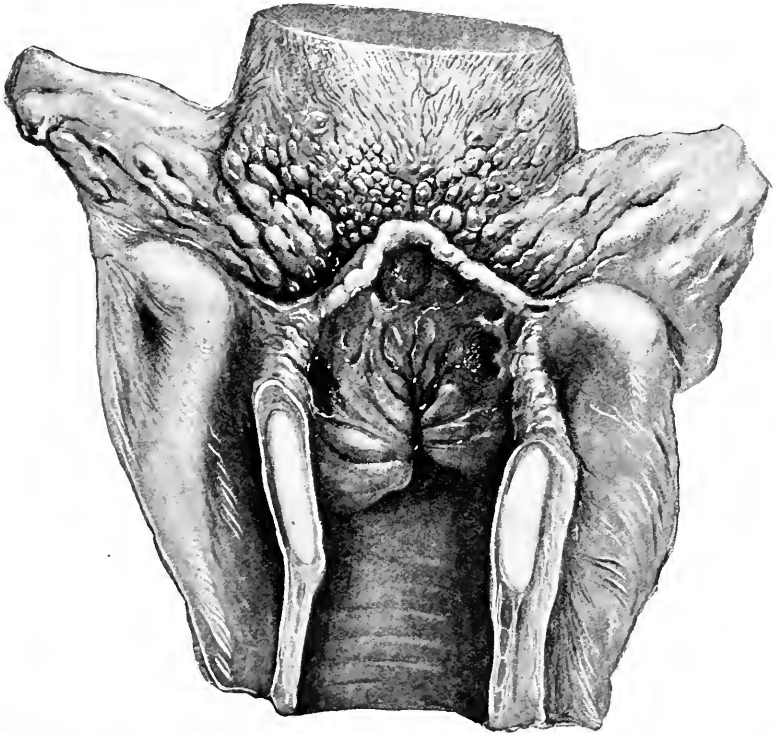
Fig. 159.   Tertiary syphilis of the larynx.   Ulceration and cicatricial contraction involving the epiglottis, vocal cords, aryepiglottidean folds.

by the absence of dysphagia, while the general condition is good and no signs are present in the lung or tubercle bacilli in the sputum.

From cancer by the more rapid progress of the ulceration without warty outgrowths, seldom commencing from the cords, by the special involvement of the epiglottis and the multiplicity of the ulcers often noted. In doubtful instances pieces should be removed for microscopical investigation.

Treatment. This is specific with neosalvarsan, iodides, and mercury ; treacheotomy is often needed where there is œdema or perichondritis, and it should be noted that administration of specific remedies may set up temporary but severe œdema and should only be administered in severe cases when the patient is under supervision, so that tracheotomy may be done speedily if required. The resulting stenosis is discussed later.

(c) *Tuberculosis of the Larynx.* This is practically always secondary to pulmonary phthisis and usually in the later stages of the disease, though occasionally arising early.

Signs. In addition to those of chronic laryngitis, dysphagia is usually a marked symptom. On inspection with the laryngoscope infiltration and ulceration will be found, especially about the posterior part of the glottis (on the cricoid), but the epiglottis is involved in some instances. The mucosa is pale and the ulcers not punched out as in syphilis, but ragged with undermined edges presenting the appearance of tags or polypi and having a gnawed appearance. Dyspnœa is exceptional, and the presence of tubercle bacilli in the sputum and signs in the lungs will make the diagnosis clear.

Treatment. In most cases palliation alone is possible owing to the advanced condition of the pulmonary changes, and consists in resting the voice, treating the lung condition, and the insufflation of antiseptic and analgesic powders, *e.g.* orthoform, to render feeding less painful. Active treatment is seldom advisable, but where the main lesion is in the epiglottis the ulcerated portion may be removed with punch-forceps after anæsthetizing locally with cocain and then rubbing on 50 per cent. lactic acid. Tracheotomy is only indicated where laryngeal obstruction supervenes, which is exceptional.

PERICHONDRITIS. Infection of the perichondrium and necrosis of the laryngeal cartilages may result from acute infection when severe, as in cases of scarlet fever, but is more usual in syphilis, tuberculosis, and cancer.

Signs. There will be swelling of the affected cartilage, which in addition to causing laryngeal obstruction may produce external swelling as well.

Treatment. The resulting abscesses should be opened from inside or outside the larynx, tracheotomy being often needed, and sequestra of cartilage are removed later. Stenosis of the larynx is likely to follow and require treatment.

STENOSIS OF THE LARYNX. This results from acute infection with perichondritis, and after the healing of gummatous ulcers where there has been much destruction.

The diagnosis is made on the history, the dyspnœa, and the deformed condition of the larynx as seen with the laryngoscope.

Treatment. The stenosis may be dilated by introducing small O'Dwyer's tubes (p. 478), which are retained a few days and replaced by larger sizes, or bougies are passed from above at intervals of a few days or from below where tracheotomy has been done. In severe cases excision of the cicatrix, after opening the larynx (thyrotomy), may be attempted. Where these measures fail the patient will have to wear a tracheotomy tube permanently.

NEW GROWTHS OF THE LARYNX. Both innocent and malignant forms are found, the latter being far more common.

Benign Tumours. The commonest are papillomas, which are usually found in children, occasionally in adults. They appear as warty, rather succulent growths of the vocal cords, and cause hoarseness and dyspnœa, which may be paroxysmal from the pedunculated growth being caught

between the cords. They are recognized by inspection with the laryngoscope, suspension laryngoscopy or the bronchoscope as cauliflower-like excres-
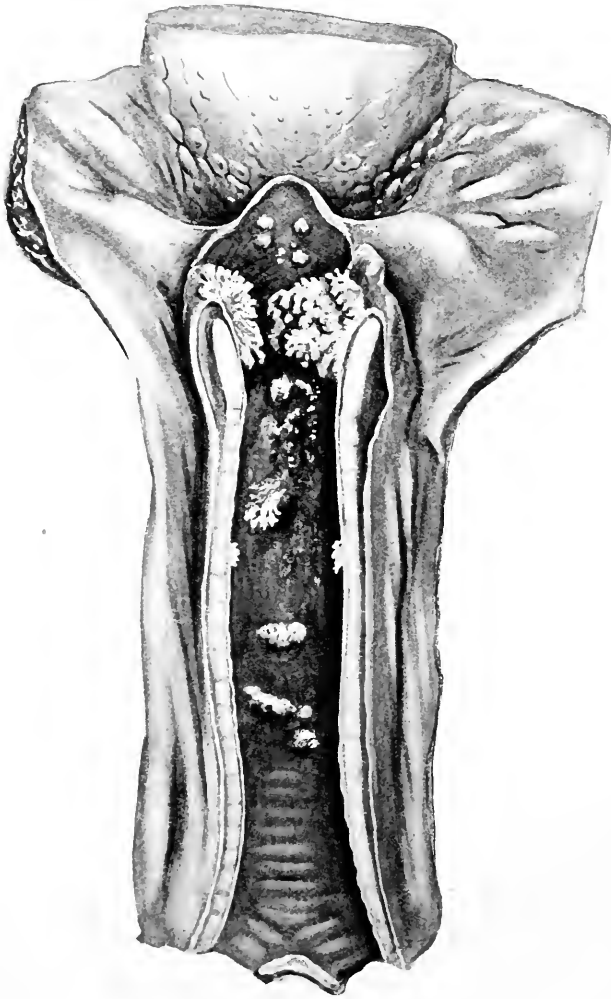
Fig. 160. Papillomas of the larynx, mostly growing from the vocal cords but also from the mucosa of the trachea.

cences, pinkish in colour, usually multiple, and tending to recur after removal.

Treatment. They are removed with punch-forceps either by direct-suspension laryngoscopy or with the bronchoscope, when recurrent thyrotomy may be done and the tumours removed with scissors. Resting the larynx by performing tracheotomy has been used with success in some instances, as this tends to make the papillomas atrophy. In adults warty growths, after removal, should be examined microscopically lest they be cancerous, when a wider excision should be performed.

Malignant Tumours. These are squamous-celled cancers found in men over forty, and may arise on the vocal cords and below these, in which case they are called *intrinsic*, or on the epiglottidean folds, in the sinus pyriformis, or the posterior wall of the cricoid or epiglottis, when they are termed *extrinsic*.

The prognosis is better in the intrinsic forms (partly because these cases are diagnosed more early, since the hoarseness brings the patient under observation quickly, and partly because the cartilaginous box of the larynx prevents rapid dissemination) than is the case when the growth is outside. As Trotter points out, the extrinsic forms may with equal fairness be regarded as belonging to the lower pharynx (epilaryngeal tumours).

Following Trotter, we may divide these growths into epilaryngeal, those of the sinus pyriformis, and true laryngeal forms.

Signs. These vary with the site of origin of the growth.

(a) The *epilaryngeal* form starts in the aryepiglottidean fold or epiglottis. There will be alteration in the quality of the voice, later hoarseness, dysphagia and dyspnœa, while examination with the laryngoscope and palpation will reveal an indurated, warty ulcer.

(b) *Cancer of the Sinus Pyriformis.* These are often long latent, the first thing noticed being enlarged cervical glands. The sinus is not visible in its deeper parts with the laryngoscope, but may be investigated with the bronchoscope and palpated with the finger, lying between the wall of the thyroid cartilage, the aryepiglottidean fold, and the posterior wall of the pharynx. This growth spreads along inside the thyroid and invades the cord, perforates the cartilage and grows along its outer surface. Since there is but little alteration in the voice and the interior of the sinus may readily escape observation, diagnosis is apt to be late. Œdema of the ary-epiglottidean fold and a persistent pool of pus in the sinus pyriformis are suggestive, as well as a swelling on the outside of the thyroid cartilage, and the indurated ulcer may be palpated in the sinus or seen with the broncho-scope. The involvement of the larynx is often extensive before the patient comes for advice.

(c) Where the growth takes origin on one of the cords (*intrinsic*) persistent hoarseness will be an early sign, and investigation with the laryngoscope will show a wart or ulcer of the cord with injection around it ; the movement of the cord on the affected side is impaired, and where there is the least doubt a piece should be removed for microscopic examination. In these cases glandular involvement is late.

Diagnosis. From gumma the lesion, being more chronic, single, and far more indurated, will distinguish ; while from tubercle the absence of phthisis, pallor of the mucosa, the unity of the lesion, and on digital examination the absence of induration, will decide ; but if doubtful a piece should be removed for examination.

Treatment. (a) Epilaryngeal tumours should be removed by the lateral thyrotomy advocated by Trotter (p. 429), which gives the best exposure and can be done without destroying the cords in suitable cases. Approach by

median subhyoid pharyngotomy may be feasible, but affords less advantageous access to the growth.

(b) Growths in the sinus pyriformis always spread to the larynx to such a degree that if operation be feasible total laryngectomy will be indicated, with removal of the deep cervical glands on both sides.

(c) For intrinsic cancer of the larynx median thyrotomy and wide local removal of the cancer on the affected side gives excellent results in early cases, and the glands may be left. Where the cartilage is affected, which occurs late, the whole or half larynx should be removed and the affected deep cervical glands excised (pp. 480–481).

Where the growth appears inoperable much alleviation may be attained by cauterizing by means of diathermy, employing the method of suspension, direct laryngoscopy (p. 454). Where dyspnœa is urgent, tracheotomy (low) will be needed (p. 476).

NERVOUS AFFECTIONS OF THE LARYNX. Interference with one or both recurrent laryngeal nerves leads to signs which may be important in the larynx as an airway, or help in the diagnosis of obscure conditions in the chest. Paralysis of one recurrent laryngeal nerve leads to immobility of the cord in the " cadaveric " position midway between the ab- and adducted positions, and will point to some tumour pressing on the nerve, e.g. aneurysm of the subclavian when the right side is affected, but of the arch of the aorta when the paralysis is left-sided. In certain affections of the recurrent nerves adductor-spasm and abductor paralysis may occur, causing immediate and grave dyspnœa from closure of the glottis, requiring laryngotomy or intubation. The affections of the neuromuscular mechanism of the larynx are more fully considered in works on medicine and laryngology.

Hysterical paralysis of the laryngeal muscles is common in young women, and the result is " aphonia " or loss of vocalized speech, though whispering is managed. Slight degrees of laryngitis may be the origin of the condition. As in other hysterical conditions, the treatment consists in persuading the patient that phonation is possible.

THE TRACHEA

Foreign bodies have been described.

The treatment of inflammations consequent on laryngitis is on similar lines. Stenosis of the trachea may result from the cicatrization of acute or, more often, of gummatous inflammations or from the pressure of external tumours, especially goitres. In the former condition intubation or the passage of bougies may be employed or, failing these, tracheotomy below the stricture. When stricture is due to pressure of a thyroid tumour a sufficient portion of the goitre should be removed (see Affections of the Thyroid, pp. 492–493).

OPERATIONS ON THE LARYNX AND TRACHEA. Operations in this region are of two main types : (a) to provide an airway when obstruction is present ; (b) to remove foreign bodies or tumours. In the first group are included tracheotomy, laryngotomy, and intubation ; in the latter subhyoid pharyngotomy, thyrotomy, lateral transthyroid pharyngotomy, and laryngectomy.

LARYNGOTOMY, OR OPENING THE LOWER LARYNX THROUGH THE CRICO-THYROID MEMBRANE. *Indications.* (*a*) In emergencies, where some foreign body has become impacted in the upper larynx and cannot be removed with the finger, rendering suffocation imminent.

(*b*) As a preliminary to the larger operations on the mouth, jaws, and pharynx.

(*a*) As an emergency or " dinner-table " operation, as there is no time to lose, the cricothyroid space is palpated with the forefinger of the left hand, the head is kept extended and strictly in the middle line, and any available knife plunged horizontally through this space into the lower larynx. Some household " dilator," such as a hairpin or toothpick, is pushed through the transverse hole and the situation saved. It is important to hear the air whistling through the hole before introducing the dilating instrument, or the mucosa of the larynx may be pushed in front (where the knife is blunt) and no good result.

(*b*) Where there is more time, as in preliminary laryngotomy, the cricothyroid space is exposed by a vertical incision, the sternothyroid muscles retracted till the thyrohyoid membrane is evident, and the knife passed with its blade horizontal through this space, keeping near the cricoid to avoid the cricothyroid artery and the vocal cords. The laryngotomy tube (which is oval in section and is curved in the direction of its least diameter) is passed, the lower pharynx packed, and anæsthesia administered through this tube. This has the advantage of taking less time than tracheotomy and that when all danger of bleeding has ceased the tube is removed and the wound rapidly heals. The operation is only available in adults, as in children the cricothyroid space is too small, and in these patients a high tracheotomy, which often encroaches on the cricothyroid space, takes its place.

FIG. 161.   Operations on the air-passages. *a*, Subhyoid pharyngotomy. *b*, Laryngotomy. *c*, High tracheotomy. *d*, Low tracheotomy. (Note the inferior thyroid veins.)

TRACHEOTOMY, OR OPENING THE TRACHEA BELOW THE LARYNX. This operation is usually done above the isthmus of the thyroid gland (high tracheotomy), sometimes cutting through the cricoid (cricotracheotomy), less often below or at the isthmus after dividing the latter (low tracheotomy).

Anatomy. The trachea is normally in the middle line (it may be pushed over by growths). In front are the sternohyoid and sternothyroid muscles

and the isthmus of the thyroid gland, which lies in front of the third, fourth, and fifth rings. The innominate artery and vein are important relations of the thoracic part.

(a) THE HIGH OPERATION. *Indications.* (a) In acute laryngeal obstruction due to impacted foreign bodies ; (b) scalds of the upper larynx in children ; (c) diphtheria ; (d) acute œdema of the larynx from simple laryngitis, syphilis, perichondritis, cancer, more rarely renal disease and tubercle ; (e) for spasm of the cords in tetanus or double abductor paralysis ; (f) for chronic stenosis of the larynx from syphilis.

Tracheotomy should not be too long delayed, especially when done in children for diphtherial laryngitis, or the patient's chances may be diminished, nor should one wait till the latter is *in extremis* with respiratory and cardiac failure. When there is marked laryngeal stridor, retraction of the sternum and lower ribs, and restlessness, operation should be no longer delayed. For when restlessness is passing off into collapse and cyanosis into lividity and pallor, the time is already passing away when favourable results are to be expected.

Operation. The patient is in the dorsal position with the head exactly in the middle line and well extended over a sand-bag to increase the length of trachea available, which in fat infants is but small ; very little anæsthetic should be given, and in urgent cases none. This applies to children ; in adults where there is less urgency, local novocain anæsthesia is sufficient.

(1) In very urgent cases where respiration has nearly ceased and every moment of prolonged obstruction is important, the cricoid should be steadied between the finger and thumb of the left hand ; the knife is then thrust into the trachea half an inch below the cricoid, with its back to the sternum, and made to cut upwards ; it is made to enter the trachea, and air is heard to whistle through before the dilator is inserted along the knife, which is retained in its position till the latter is securely home. The tube is then inserted and tied in ; artificial respiration and stimulants may then be needed.

(2) In less urgent cases an incision is made from the lower border of the thyroid cartilage an inch and a half down in the middle line ; veins are picked up and the sternothyroid muscles separated till the rings of the trachea are felt with the left forefinger, the pulp of which rests on the cricoid. The knife is thrust into the trachea with its back to the sternum (the object of this is that, as the trachea is dragged down on inspiration, the movement will tend to enlarge the opening in the latter, while if the back of the knife be turned to the cricoid the hole made in the trachea may be too small). Some steady the cricoid with a sharp hook, but we have found the method described more satisfactory. The knife is retained in position till the dilator is introduced, and this kept in till the tube and pilot are inserted. The pilot is removed and the tube tied in place ; the incision in the skin is partly closed and a small piece of dressing introduced between the flanges of the tube and the skin. Lowering the head at the close of operation will prevent blood passing into the trachea. The best tube for general use is

that devised by Parker, in which the limbs of the tube are straight and united at an obtuse angle. Tubes which form part of the segment of a circle are too curved, so that their inner orifice often impinges on the front wall of the trachea and may be obstructed by, or cause ulceration of the latter. In adults the dissection may be more deliberate and the rings of the trachea actually seen before the latter is opened.
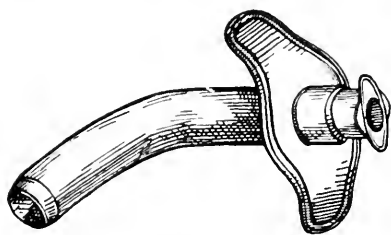
Fig. 162. Parker's tracheotomy tube, showing two limbs united at an obtuse angle.

Where there is false membrane in the trachea it may be removed by suction with a syringe to which a rubber tube is attached, which is better than cleaning with sterile feathers. In infective cases, such as diphtheria, a layer of gauze should be laid over the tube to prevent dissemination by coughing.

(b) THE LOW OPERATION. This is seldom indicated, but may be employed in cancer of the larynx, either as a palliative measure or as a preliminary to laryngectomy. It may also be employed in cases of stenosis of the trachea, below the obstruction. This method was formerly employed to extract foreign bodies from the trachea and bronchus, but the use of the bronchoscope is far better than blindly groping through a tracheotomy wound.

Operation. The position is as before and the incision commences half an inch below the cricoid, extending to the sternum. The simplest plan is that of Crile, who divides the isthmus of the thyroid between ligatures and retracts the latter with the sternothyroid muscles. The operation is rendered more difficult than the thigh operation, partly by the greater depth and partly by the inferior thyroid veins, which may require ligature ; in some instances the left innominate vein will come into view, and must be avoided. The trachea is opened under guidance of vision, the rings being clearly seen.

The tube employed is somewhat different from that for the high operation, as the cervical limb must be longer owing to the greater depth of the trachea ; nor should the tracheal limb be over-short, or it may escape from the trachea, causing grave dyspnœa.

Where immediate laryngectomy is contemplated the tube must be of the Hahn or Trendelenberg type, *i.e.* surrounded in its tracheal portion with a sponge or dilatable rubber bag, either of which dilates and fills the rest of the trachea and so prevents passage of blood into the bronchi and lungs. Where laryngectomy is to be deferred for some days gauze is packed around the trachea and into the wound to cause formation of adhesions, which later prevent the trachea sinking back and check the dissemination of infection and suppuration in the deeper cervical planes.

DIFFICULTIES IN TRACHEOTOMY. Most of these arise from omitting to keep the head in the middle line. This depends on the assistant or anæsthe-

tist, who must on no account turn the head over. The surgeon may also be at fault in pushing the trachea over while attempting to steady it ; finally, the trachea may really be on one side, as in malignant growths of the thyroid.

Hæmorrhage may be troublesome but, being chiefly venous, is readily stopped if time allows, though in critical cases it is often wiser to risk some bleeding and go ahead with opening the trachea, as bleeding usually ceases when the dyspnœa is relieved, and if the head be dropped there is little risk of blood being inhaled. Perhaps the most common mistake of the beginner is in not properly entering the trachea, either making too small a hole or pushing in the mucosa in front of the tube when inserting the latter (due to too small an opening), or from pushing the tube down alongside the trachea, between the latter and the surrounding fascia. If the knife be pushed well home with its edge to the cricoid, as directed, and not removed till the dilator is in its place, this mistake will be avoided. It is important to note the whistling of air after incising the trachea, and if this does not happen it is fairly certain that the latter is not properly opened. The possibility of tubes made in the form of segments of a circle being blocked by impinging against the anterior wall of the trachea has been mentioned. Where the tube is inserted and no air passes even when artificial respiration is performed it must be taken out, the trachea discovered again, and a new hole made (the former was probably not really in the trachea) rather than an attempt made to find the original opening.

After-treatment. This applies chiefly to cases suffering with diphtheria, but may be employed with but slight modifications to other cases. The air of the room should be warm and not too dry ; a bronchitis-kettle and screen to keep off draughts will be comforting, but to envelop the patient in a closed cot the atmosphere of which is saturated with steam will only depress the vitality without doing any good. The inner tube is removed six-hourly, cleaned in soda solution and boiled daily. The aperture of the outer tube is lubricated with a spray of bicarbonate of soda 3 per cent., carbolic acid 1 per cent., or of menthol and eucalyptus in parolein. Blocking of the tube with membrane or mucus is removed by sucking out by means of a syringe at the end of a rubber tube, and never by sucking with the mouth. Feeding should be liquid but nutritious, and where there is much pain on deglutition nasal feeding with catheter is indicated.

The tube should be removed as soon as possible in diphtheria cases and those of acute œdema ; this may often be done within two days, all depending on the condition of the larynx. Where foreign bodies are impacted they, of course, must be removed and the œdema subside first. Where the patient has attacks of dyspnœa as soon as the tube is removed, a form of tube is employed with an aperture at the angle of the tube towards the larynx as well as at the ends. Where this does not restore laryngeal respiration the outer aperture is gradually diminished till all the air passes by the larynx.

COMPLICATIONS. (*a*) Ulceration of the trachea by the tube, if not fitting properly (the advantage of Parker's tube has been pointed out).

Where the tube has to be retained for a long time one of rubber may be substituted.

(b) Infections about the tube may follow in patients of low vitality and lead to cellulitis of the neck, mediastinitis, secondary hæmorrhages, especially in the low operation. Opening freely and irrigation with peroxide of hydrogen may improve these cases, but they often end fatally.

(c) Broncho-pneumonia may result from extension of infection downwards, and is a serious and often fatal complication. This is treated by sitting the patient up, administering expectorants, stimulants, and oxygen.

(d) Difficulty in breathing without the tube may arise from keeping in the tube too long and so creating a habit of tube-breathing, or from granulation and cicatricial contraction blocking the larynx after severe infections.

The treatment of the first condition has been mentioned; where there is stenosis, the larynx is dilated by pushing up bougies from below till it is sufficiently pervious (Macewen) or by intubation (see below).

INTUBATION OF THE LARYNX (O'DWYER) WITH TUBES. This plan is employed as a substitute for laryngotomy or tracheotomy. The tubes are of graduated size and oval in section to fit the glottis. They are introduced and extracted with special instruments. The child is held firmly on the lap of the nurse facing the surgeon, who introduces the left forefinger down the throat, hooks up the epiglottis and inserts the tube on the introducer, pushes the former into the glottis till it is firmly caught, and then displaces it from the introducer by using the lever in the handle.

It is important to pass the tube during inspiration. The tubes may be employed in acute obstruction from laryngitis and diphtheria and in cases of difficulty in breathing through the glottis after tracheotomy or to improve stenosis of the larynx.

For laryngeal obstruction this method has the merit of involving no open wound, no anæsthetic, the air breathed is warmed by passing through normal passages and it is rapidly done (by those in practice). The disadvantages are:

(a) There may be difficulty in the introduction where there is much œdema.

(b) It may not relieve obstruction where membrane is pushed down into the trachea.

(c) It may be coughed out, and if there be no skilled assistance the patient may perish from obstruction.

(d) Ulceration of the glottis may result from pressure.

(e) Feeding may be more difficult than after tracheotomy.

Intubation is therefore only advisable where skilled assistance is always to hand, in order to replace expectorated tubes, i.e. in fever hospitals, and where there is not much membrane. For the general practitioner, who only occasionally deals with these cases and cannot always be with the patient, a tracheotomy-tube, well tied in, is far safer.

In acute conditions the tube may be removed in three or four days.

In general, intubation will be more useful in cases of laryngeal stenosis than in acute obstruction of the larynx.

OPERATIONS FOR REMOVAL OF FOREIGN BODIES OR GROWTHS. (a) *Median Pharyngotomy.* This may be effected by cutting through the thyrohyoid membrane transversely (subhyoid pharyngotomy of Malgaigne).

It will give a better access if the pharynx be opened vertically in the middle line, dividing the hyoid bone (transhyoid pharyngotomy).

In either case tracheotomy is first performed and a Hahn or Trendelen-berg tube inserted. This method of access may be useful to reach foreign bodies impacted in the upper larynx which are not removable by mouth, but for growths of the upper larynx and lower pharynx the next route gives better access.

(b) *Lateral Trans-thyroid Pharyngotomy* (Trotter). This would appear to give the best access to extrinsic cancers of the larynx, *i.e.* those of the epiglottis and aryepiglottidean folds and of the lower pharynx; it also affords opportunity for moving glands on the affected side.

The view of the upper opening of the larynx is excellent, allowing concise and complete removal of the growth with a wide margin.

Operation. A preliminary tracheotomy and insertion of a Hahn tube should be done either at the commencement or before the pharynx is opened. The incisions are as for removing malignant glands, viz. along the sterno-mastoid and from the middle of this to the symphysis menti. It is a good plan to leave a flap of fascia continuous with the sternomastoid to cover over the carotid vessels when the dissection of the glands is completed. The glands are removed to the base of the skull and the external carotid removed; in addition the sternomastoid and jugular may be sacrificed. The fascial flap mentioned above is sutured over the large vessels to the prevertebral muscles, thus preserving the former from risk of infection and secondary hæmorrhage.

The side of the great cornu of the hyoid and lateral part of the thyroid cartilage are cleared of muscles, viz. the inferior constrictor, stylopharyngeus, hyoglossus, sternohyoid, and sternothyroid. The great cornu of the hyoid and posterior two-thirds of the thyroid cartilage are removed, and the lateral wall of the pharynx is thus exposed and opened longitudinally. On retracting the edges of the incision the upper opening of the larynx is well exposed and the extent of the growth is made out, and it is removed with a wide margin and the wound obliterated with mattress sutures passed deeply. The opening in the pharynx is closed with inverting mattress sutures, and separate drains pass down to the wound in the pharynx and that for removing the glands, both of which are removed in twenty-four hours. The tracheotomy-tube is left in for a week, and feeding is by catheter through the nose for ten days.

Through this route growths of the lower pharynx or upper œsophagus may be removed and the resulting gap replaced by flaps turned in from the skin of the neck. Where the part removed is from the back of the pharynx the skin-flap hinges from the outer part of the incision in the neck,

but if from the anterior part from the anterior part of the skin-incision (Trotter).

THYROTOMY; MEDIAN LARYNGOTOMY. This is useful for removing growths of the vocal cords or subglottic space when discovered early, occasionally for removing foreign bodies. A preliminary tracheotomy and plugging of the trachea is done. An incision is made from the hyoid to the cricoid in the middle line and the depressors of hyoid and larynx cleared from the cartilage. The thyroid cartilage and the underlying mucosa are split in the middle line and the two halves retracted, thus freely exposing the cords. Papillomas are freely excised and their bases cauterized with silver nitrate. Where the condition is cancer the cord and tissues under it should be removed with a free margin, if necessary to the cartilage. If, however, the perichondrium be affected, it will be necessary to remove half the larynx at least. The wound inside the larynx is approximated with obliterating mattress sutures and the thyroid accurately closed again. The tracheotomy-tube (after removing the plugging) is retained for several days. In operating on the glottis it is a good plan to cocainize the region first, as this prevents respiratory spasm even with light anæsthesia.

LARYNGECTOMY, OR EXTIRPATION OF THE LARYNX. This may be of the half or whole larynx. Removal of half the larynx is indicated for growths of the cords affecting the cartilage or where glandular infection is present. Complete laryngectomy is employed for growths of the sinus pyriformis, which always spread widely in the larynx before diagnosed and for growths of the cords and extrinsic cases when advanced, though the latter cases, if not removable by the transthyroid pharyngotomy, will generally prove inoperable.

Hemilaryngectomy. This is indicated where the growth is intrinsic and has spread to the perichondrium but not to the other side of the larynx, and is likely to develop out of a thyrotomy, where it is found that the growth is too extensive to be removed without removing the cartilage.

Tracheotomy and plugging the trachea will already have been done, and the thyroid cartilage is split in the middle line as described. The upper end of the original incision is extended outwards on the affected side and the muscles cleared from the front and outer side of the laryngeal box. The thyrohyoid membrane and superior cornu of the thyroid are divided and the attachments to the pharynx at the back divided well free of the growth. The cricoid is divided in the middle line, front and back, and separated from the trachea, thus enabling the half-larynx to be removed. The wound is pulled together with deep mattress sutures and packed with gauze for a few days, the skin-incision being partly closed and the tracheotomy-tube being kept in for several days. The patient is kept with the head lowered and turned on the affected side to admit of free drainage of secretions. Nasal feeding is employed and the deep cervical glands on the affected side are removed later.

Complete Laryngectomy. This is indicated in most operable cases of cancer starting in the sinus pyriformis and for intrinsic cancer which involves both sides or where glandular infection is present on both sides.

Operation. The larynx is exposed by a median incision from the hyoid to below the cricoid with transverse incisions at the upper end. The muscles are separated from the front of the larynx till the attachments of the pharynx are reached, and this is dissected off the larynx, leaving a hole in the front of the pharynx, which is carefully sutured with three layers of sutures and often remains watertight, feeding with a nasal tube being employed for the first three days. The main question is what to do with the trachea below. This may be opened by low tracheotomy several days beforehand and the trachea packed round with gauze to cause the formation of adhesions (Crile) and prevent the trachea later sinking back into the neck when the larynx is removed, as in that case secretions of the wound and the pharynx will pass into the lungs, causing pneumonia. The other plan (Gluck) is to leave the trachea untouched till the final operation, when by a long anterior incision the larynx and trachea are bared in front and the dissection carried right round the trachea at the sides, freeing it from the œsophagus. The trachea is not opened till entirely free of the œsophagus, when it is cut through a short distance below the larynx, and the upper end of the lower portion is brought through a stab-wound in the skin just above the sternum and secured there with sutures. The anæsthetic is then administered through the cut trachea and removal of the larynx continued, dissecting from below upwards. This method has given good results in the hands of Gluck. Other surgeons find that the trachea comes away from the skin and sinks into the neck, leading to broncho-pneumonia; and hence advocate preliminary low tracheotomy and packing round with gauze for several days after the method of Crile. Where this method is employed the excision of the larynx proceeds on the lines described above, dividing the trachea at its upper end; the stump of the trachea which is left above the tracheotomy wound is curetted to remove the mucosa and packed with gauze for some days, when it will heal by granulation.

In all cases the glands are removed by a second operation, except after thyrotomy.

RESULTS OF EXCISION OF CANCER OF THE LARYNX. After removal by thyrotomy there may be a fair power of vocalization; even after removal of the half-larynx some power of phonation is possible. After removal of the whole larynx whispering only is possible, but may be cultivated till conversation is tolerable at short distances.

Results of Operation (the results of several authors—Butlin, Gluck, Semon). Thyrotomy has the lowest death-rate, about 6 per cent., and about 50 per cent. or more of cures of a year or more duration (recurrence is uncommon after a year in this situation).

Hemilaryngectomy. The mortality varies from 25 per cent. to nil (Gluck) and the cures after three years about 20 per cent. (Butlin). For complete

laryngectomy the mortality in the hands of specialists is about 15 per cent. ; the cures are uncertain.

The figures show one thing, at any rate, viz. the extreme importance of early diagnosis and, further, of the relative innocency of the intrinsic forms ; for this sort are removable by thyrotomy, while amongst the larger operations are included many of the extrinsic, more rapidly growing types.

SURGERY OF THE NECK

In this section are included certain injuries, inflammations, &c., chiefly of the fascial planes of the neck.

Anatomy. The neck may be regarded as formed of two main compartments, the posterior or skeletal, consisting of the spine with the anterior and posterior spinal muscles, limited in front by the prevertebral fascia. The anterior or viscerovascular compartment contains the respiratory and digestive tubes, the surgery of which is included in this section.
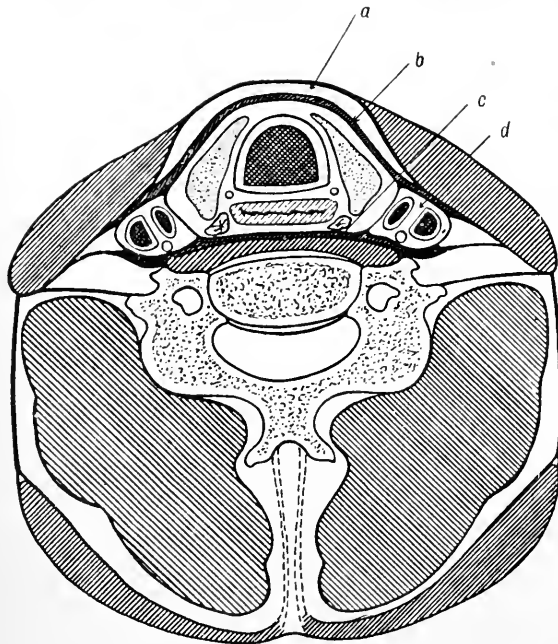
FIG. 163. Diagrammatic section of the neck to show the cervical fascia. *a*, Common encircling layer of deep fascia. *b*, pretracheal fascia. *c*, Prevertebral fascia. *d*, Carotid sheath.

The cervical fascia is a dense membrane investing the neck in its whole contour. The fascia splits in front and behind to enclose the trapezius and sternomastoid, and above is attached to the skull between these muscles and further forward to the zygoma and lower margin of the lower jaw, below to the clavicles and sternum. From this embracing fascia partitions pass inwards, separating the structures of the neck. The prevertebral fascia separates the skeletal and muscular structures of the spine from the visceral and vascular structures in front. The pretracheal fascia bounds the visceral compartment in front, including the larynx, pharynx, trachea, and thyroid gland. At the sides of the visceral compartment the vessels, with the vagus sympathetic and lymphatic glands, lie in a longitudinal compartment made by the fascia called the "carotid sheath." The visceral compartment is continuous below with the superior and posterior mediastina, allowing an easy track for the spread of infections.

Landmarks. In the middle line the body of the hyoid is level with the fourth cervical vertebra ; immediately below this is the prominent " pomum Adami " of the thyroid cartilage, below which again is the cricoid cartilage level with the sixth cervical vertebra. Below this the rings of the trachea may be felt, the second, third, and fourth being covered with the isthmus of the thyroid. The great vessels lie under cover of the sternomastoid.

INJURIES OF THE NECK. We allude here to those of the anterior compartment ; injuries of the spinal column are described under the Nervous System (pp. 644–647).

Injuries from blunt violence may lead to fracture of the hyoid and thyroid cartilage, which are described earlier in the present chapter, since their most important consequence is œdema of the larynx (p. 466).

WOUNDS OF THE NECK ; CUT THROAT. These are usually suicidal, less often homicidal in origin, and those affecting the lateral aspects are more dangerous than those in the anterior portion, since the large vessels lie at the sides.

These incised wounds are, roughly, horizontal, and seldom divide the great vessels owing to the intervention of the trachea or larynx and sterno-mastoid, but occasionally these important structures are divided, in which case the patient will probably succumb before any treatment can be attempted. The most usual level for the wound is between the hyoid and thyroid, dividing the thyrohyoid ligament and perhaps opening the pharynx. There may be difficulty in swallowing from cutting of the depressors of the hyoid, but little effect on respiration. Less frequently the thyroid cartilage or trachea is cut through, when there may be bleeding from veins or the superior thyroid artery, and difficulty in respiration from affection of the vocal cords or blood in the trachea. Where the cut is above the hyoid the linguals and facials may be injured, the base of the epiglottis divided or the tongue injured, which may fall back and interfere with respiration.

The immediate dangers are from hæmorrhage, entrance of air into veins, respiratory embarrassment from inspiration of blood or the tongue falling back ; later dangers are œdema of the larynx, spread of sepsis along the cervical fascia to the mediastinum and pericardium, aspiration-pneumonia : surgical emphysema is common but of little significance.

Treatment. Arrest of hæmorrhage and cleansing the wound are the first indications—possibly tracheotomy where respiratory trouble is great. The question of suturing the wound then arises. Above the larynx, *i.e.* in the thyrohyoid space and above this, the wound should be closed in layers, starting with the mucosa, replacing the muscles and finally the skin, draining for twenty-four hours, but tracheotomy is not necessary. Where the wound is in the larynx a high tracheotomy should be performed and the divided parts carefully sutured in layers : the tube is kept in a few days till all danger of œdema of the glottis has passed. Wounds of the trachea should be partially sutured and a tracheotomy-tube inserted for a few days. The superficial muscles should always be sutured as far as possible. When in doubt tracheotomy will do no harm. Feeding by the nose with catheter

may be needed for a few days, but is often unnecessary. Watching for further attempts at suicide rests with the police. Later results, viz. fistulæ of the larynx, pharynx, œsophagus may result, or laryngeal stenosis ; in the pharynx these usually close, but the air-passages may need plastic operations.

These patients are usually miserable, half-starved specimens, and good feeding forms an essential part of the treatment.

INFECTIONS OF THE NECK. Acute cellulitis of the neck is due to infection of the deeper planes, usually with streptococci, and is a serious condition on account of the connexion of the cervical fascia below with the mediastinum and pericardium, not to mention the ease with which infection spreads to the larynx, leading to œdema of the glottis and severe dyspnœa.

Cellulitis of the neck is often the result of acute infection of lymph-nodes, with subsequent spread from these to the fascial planes. One of the most common and important places for this infection to take place is in the tissues and lymphatics about the submaxillary gland and floor of the mouth. Cellulitis in this region is known as *Ludwig's angina*, and originates from the floor of the mouth, carious teeth, &c. In other instances the primary focus often remains undiscovered and the cellulitis starts in the deep cervical glands or the thyroid.

Signs. The onset is usually acute, with fever, malaise, and a tender, brawny swelling appearing in the neck about the submaxillary gland (in cases of the Ludwig type), or lower in the type affecting the deep cervical or thyroid glands. In some instances, however, the onset is subacute, with the appearance of a hard, deep-seated swelling, which is not very tender at first but which gradually increases in size and becomes more acute, till after some days its virulent nature is clear. General disturbance is usually marked, and even where there is no fever there is considerable depression, loss of appetite, &c.

Later the neck becomes enormously swollen, hard, brawny, while pitting œdema and redness are noted. Owing to the density of the fascia, the condition seldom points on the surface before signs of œdema of the larynx or great depression shows the urgent need of surgical intervention.

Diagnosis. The appearance of a brawny, ill-defined mass in the sub-maxillary region with general signs of inflammation, whether acute or subacute, are not likely to be caused by any other condition, and will suggest operative measures before the onset of œdema of the glottis adds to the gravity of prognosis.

Treatment. Free incisions should be made into the most brawny part of the swelling, with due regard to the large vessels in the vicinity ; when the incision has reached the depth of one half to three quarters of an inch it is as well to proceed with sinus-forceps, making exploratory punctures in the most likely directions till pus or much turbid serum is found (in most instances breaking-down foci will be found and the pus can be evacuated). The surgeon should not be over-anxious of injuring vessels with sinus-forceps, as this is unlikely, and finding pus early may prevent grave spread of the

infection.   When pus is found the opening into the abscess should be enlarged and in the vicinity of large vessels drained with a light gauze pack.   For in these situations drainage-tubes are to be strictly avoided, as being likely to erode vessels and cause fatal secondary hæmorrhage.   Irrigation with peroxide of hydrogen should be employed when the abscess is opened.

Where laryngeal obstruction is marked tracheotomy should be performed, and this may be a necessary antecedent to operating on the cellulitis.   Both sides of the neck may require incisions, and the latter can hardly be too free.   The prognosis in this condition is always grave, especially in old or alcoholic subjects, spread to the lungs, mediastinum, pericardium, being not uncommon.

Actinomycosis.   The neck is a favourite site for this disease, which is found as a brawny mass causing little pain or constitutional disturbance, which slowly breaks down, opening by many fistulæ and discharging the characteristic pus containing granules or colonies of the organism.   Free removal and administration of iodides give a fair prognosis.

TUMOURS AND CYSTS OF THE NECK.   These have for the most part been described, especially those in the middle line and along the vessels.   In the middle line are found skin-dermoids, thyroglossal cysts and fistulæ (pp. 366–367) (enlargement of the thyrohyoid bursa is said to be the origin of some cysts in this region) ; lower down the tumours of the thyroid will be noted (pp. 487–496).   At the sides of the neck branchial cysts and fistulæ have been described, as well as enlargement of lymph-nodes from infections (tubercle, syphilis), primary and secondary new growths.

It is worth noting that cancer may take origin in the relics of the branchial epithelium, and this will account for some instances of malignant glands occurring in the neck where no primary focus can be found.   Many cases, however, regarded as of this nature turn out to be due to cancer of the sinus pyriformis or other part of the upper respiratory tract, the primary growth remaining small and escaping notice during life.   Another variety of tumour is that of the *carotid body,* which forms a slow-growing tumour of the " mixed type," usually described as an endothelioma.   This tumour often pushes the carotid up, causing transmitted pulsation : removal is difficult unless one or other of the carotids be tied, and perhaps the jugular as well.

SURGERY OF THE THYMUS

This mass of lymphoid tissue in the upper thorax is enlarged considerably in the condition known as the " status lymphaticus," in which there is a general hyperplasia of the lymphatic system and a deficiency in size and strength of the cardio-vascular system, resulting in sudden death on even slight exertion or under anæsthesia, and accounts for some anæsthetic fatalities.

Enlargement of the thymus is supposed to be the cause of some forms of *asthma* (*i.e.* difficulty of respiration confined to expiration, while inspiration is easy).   Cases of dyspnœa of this type have improved after the thymus has been exposed by an incision from the neck and displaced.

SURGERY OF THE THYROID GLAND

Anatomy. The thyroid gland consists of two lateral lobes united by the median isthmus, and lies behind the pretracheal fascia. The lateral lobes extend half-way up the side of the larynx and down the first six rings of the trachea, and are related to the great vessels at the sides, to the pharynx, œsophagus and prevertebral muscles behind, while in front they are covered by the depressor muscles of the hyoid and larynx. The isthmus is opposite the second, third, and fourth rings of the trachea. The gland is attached to the trachea and larynx by the surrounding fascia, so that it moves with these in the act of swallowing. The blood-supply is very extensive ; the superior thyroid arteries from the external carotid enter the upper poles of the lateral lobes, while the inferior thyroids from the subclavian supply the inferior poles ; the veins drain into the internal jugulars and left innominate vein.

The *accessory thyroids* are small isolated masses of thyroid tissue found in various situations in the neck, upper thorax, and even in the tongue (lingual thyroids). They are subject to the same affections as the main gland, and if the latter be entirely removed may in some instances be of sufficient size to take on its functions ; this, however, is so uncertain that there is no excuse for removing the whole gland.

PARATHYROIDS. These small but much discussed structures are usually four in number, lying behind the lateral lobes of the thyroid, the upper pair being opposite the middle of the lobe and the lower pair at the lower pole. These structures resemble in cellular structure the thyroid, but the cells are not arranged to form vesicles, nor is any colloid material present ; their blood-supply is extensive, from the inferior thyroid artery.

FUNCTIONS OF THE THYROID AND PARATHYROIDS. In the vesicles of the thyroid is a colloid, albuminous substance containing iodine (thyro-iodine), which is absorbed by the lymphatics (since there are no secretory ducts) and is essential to the well-being of the body in general. Deprivation of this secretion leads to myxœdema in adults, but in the young to the condition known as " cretinism." Myxœdema is characterized by mental dullness, thickening of the subcutaneous tissues, with the deposits of a gelatinous substance, dryness of the skin, loss of hair, subnormal temperature, slow pulse, slow cerebration, and lowered metabolism. The cretinoid condition is similar, but as it commences in the young developing organism, the changes are more profound. The mental condition is idiocy, the growth is stunted, there are the same pseudo-obesity, dry skin, scanty hair, and diminished metabolism ; both these conditions of " hypo-thyroidism " are improved by administration of thyroid extract.

The converse condition, or " hyper-thyroidism," also occurs, in which the absorption of thyroid secretion is excessive. Graves's disease, or exophthalmic goitre, is a special form of this condition, but similar states are caused by overdosing with thyroid extract. The mental condition is over-active and excitable, the pulse is rapid, the tissues waste, the skin is

moist and sweats freely, the patient always feeling too warm, and metabolism in general is increased.

The *parathyroids* are considered by some to be simply accessory thyroids in which no colloid is present ; other observers claim that the twitching, convulsions, and tetany found in animals after removing the whole thyroid are due to removal of the parathyroids, that removal of these alone can produce the same effects, and that where death from tetany results after partial thyroidectomy there are no parathyroids on the unoperated side to be found post-mortem ; further, that grafting parathyroids in such cases may prevent death from tetany. The administration of calcium lactate is said to have a similar good effect.

We must at present regard these findings as open to question, but till it is certainly proved that the parathyroids are only aberrant, colloidless portions of thyroid tissue it will be wiser to leave the lower posterior part of the lateral lobe of the thyroid when performing thyroidectomy so as to conserve what may be highly important structures.

ACUTE INFECTIONS OF THE THYROID ; THYROIDITIS. These are uncommon, but may result from wounds, in the course of general infection, such as enteric, pyæmia, influenza, &c., and may affect a normal gland or one pathologically enlarged. Suppuration is frequent, though resolution sometimes takes place.

Signs. The onset is acute, a tender swelling appearing in the position and sometimes of the shape of the thyroid ; high fever is usual and rigors may occur. The infection tends to spread along the cervical fascia as in cellulitis of the neck, of which it is a form, and reaches the mediastinum or pericardium. There may be dyspnœa from pressure on the trachea.

Treatment. In the milder forms, where there is little constitutional disturbance and slight swelling, it is reasonable to temporize with fomentations and purges, keeping the patient in bed. Where, however, the infection is acute with much swelling or dyspnœa, high fever, &c., operation is urgently needed, whether suppuration be diagnosed or not, owing to the risk of further spread. The gland should be exposed by an incision along one or other sternomastoid, according to the position of greatest swelling, or the " collar incision " may be employed, retracting the sternohyoid and sternothyroid. The boggy mass should be opened with sinus-forceps and drained. Secondary hæmorrhage is to be feared in acute cases owing to the large vessels in the gland.

CHRONIC INFECTIONS OF THE THYROID. Tubercle and syphilis are hardly known, but a fibrous induration of the gland, apparently often due to mild pyogenic infection, leads in some instances to the condition known as " ligneous thyroiditis," in which there is enlargement of the gland moderate in extent but of wooden hardness ; dyspnœa may result from pressure on the trachea, and dysphagia, while later myxœdema may ensue.

The condition has to be diagnosed from malignant growths of the thyroid which also are hard, by the early age, absence of ulceration into the trachea (causing hæmoptysis in cancerous goitre), by the uniform enlargement of

the gland, while cancer is irregular in its distribution, and by the absence of enlargement of lymphatic glands.

Treatment. The half or more of the gland is removed to relieve pressure on the trachea : where myxœdema follows, thyroid extract will be needed internally.

GOITRE

The term bronchocœle, or goitre (the latter term a corruption of the Latin *guttur* or throat), is loosely applied to any enlargement of the thyroid gland which is not definitely of inflammatory origin. Swellings of the thyroid are of importance partly from their local action, such as pressure on the trachea, and also from the fact that enlargement of the glands is often associated with alterations in its secretion, which cause alterations in the general condition of the patient both from hypo- and hyper-secretion of thyro-iodine.

Thus hypo-thyroidism, whether of the congenital type (cretinism) or the acquired form (myxœdema), may be associated with atrophy of the gland but not infrequently with tumour-formation, the tumour causing diminished glandular activity. Hyper-thyroidism is usually associated with over-growth of the gland as well as abnormally increased function, but the former is often not very great. Surgical interest centres mostly in enlargement of the gland, causing pressure signs, and in hyper-thyroidism ; the other conditions may be dismissed briefly, viz. atrophy of the gland (causing myxœdema) and its failure to develop (causing cretinism), the treat-ment of which is fully described in works on medicine and consists in increasing the amount of thyro-iodine in the body, usually by feeding on various extracts of the gland.

Enlargements of the thyroid, or goitres, fall into three main divisions : (*a*) simple enlargement ; (*b*) malignant enlargement (in neither of which is there, as a rule, much change in the secretive effects of the gland, though either hypo- or hyper-thyroidism may occur) ; (*c*) enlargement of the gland with hyper-thyroidism, including Graves's disease and allied conditions.

(*a*) SIMPLE GOITRE. There are two main forms of the simple goitre, viz. the *parenchymatous* and the *adenomatous*, while secondary varieties arise from these, as cystic, pulsating, acute, calcified, fibrous, &c.

Pathology. (1) *Parenchymatous Goitre.* There is hypertrophy of all the tissues of the organ, which may be most marked in the glandular acini or in the fibrous framework. Some of the latter conditions are due to chronic thyroiditis, mentioned above as ligneous thyroiditis. The causes of these goitrous enlargements are still to a large extent uncertain. The disease occurs sporadically, but is endemic in certain districts, notably in some valleys in mountainous parts, as the Peak district in Derbyshire (hence the term " Derbyshire neck "), in Switzerland, and in the Himalayas, usually when the geological formation is carboniferous limestone and green-sand. The underlying cause has been proved with fair certainty to be derived from drinking-water, and is of organic nature since it is destroyed by boiling ; also it is probably absorbed through the intestines, since McCarrison has

shown that intestinal antiseptics (thymol grs. 10, thrice daily) prevent the formation of goitres and improve them when present. The organism has not yet been isolated, nor is it certain that only one is responsible.

(2) *Adenomatous Goitre.* In this condition there are localized encapsuled new growths, just as are found in the prostate or breast, which may contain cysts or intracystic papillomas.

Three forms may be distinguished (Berry) :

(*a*) The fœtal, in which the glandular acini contain no colloid, the cells being close together.

(*b*) The cystic or colloid, which resembles in structure the normal thyroid, but the acini are irregular and run together, forming cysts, into which hæmorrhages are frequent.

(*c*) Adenomas containing cysts inside which are papillomatous outgrowths. Adenomas are encapsuled, and in the early stages may be readily enucleated. They are often multiple and subject to secondary changes as follows :

Fig. 164.   Parenchymatous goitre.

(3) *Cystic Goitre.* This condition usually results from degeneration in the substance of an adenoma, with coalescence of the acini and sometimes hæmorrhages. More rarely cysts form in parenchymatous goitres apart from adenomas, while occasionally such conditions as serous cysts and hydatids may be found.

(4) *Vascular Goitre.* This term is rather of clinical than pathological significance, since there is but rarely much increase in the vascular elements ; but where there is a rapid pulse, bounding carotids, and low blood-pressure, such as found in definite Graves's disease or allied conditions of hyper-thyroidism, the impression is conveyed clinically of increased vascularity of the goitre (pulsating goitre). Other conditions where hæmorrhages have occurred into cysts of goitres have been called vascular goitres : on the whole the term is better dropped, and is mentioned here to explain its meaning.

(5) *Calcification* is not uncommon in old-standing goitres, especially where cystic degeneration has taken place. The importance of this condition is in diagnosis, since the presence of hard lumps in goitres, found in the middle-aged, suggest calcification or malignant disease.

(6) *Fibrous goitres* may be of the endemic variety, the increase being in the stroma of the gland rather than in the secreting substance. The condition of wooden hardness is due to infections, and is sometimes included

amongst simple goitres ; thyroid deficiency and myxœdema are especially prone to occur in this form.

(7) *Acute goitre* is not common and is generally found in young persons, the thyroid rapidly enlarging in a few weeks and causing pressure on the trachea : of the cause nothing is known.

It will be noticed, then, that two different conditions are classed under simple goitre, viz. : (*a*) affections which are almost certainly infective, including endemic, sporadic, fibrous, and acute goitre ; (*b*) new growths, including adenomatous and most cystic forms.

Results of Goitre. Apart from the question of increased or diminished thyroid secretion, goitres cause pressure phenomena :

(*a*) *On the Trachea.* When the growth is of one lobe the trachea is pushed to the opposite side and kinked, the wall becoming atrophic at the place of pressure and the calibre diminished. Where the tumour is on both sides the trachea is compressed laterally and its lumen becomes a mere chink (scabbard - trachea). More rarely it is compressed from before backwards by tumours of the isthmus.

Fig. 165. Large adenoma of the thyroid of many years' duration with cystic degeneration.

As a rule the pressure is exerted in the neck, but in some instances the tumour burrows into the mediastinum (intrathoracic goitre), pressing on the lower trachea out of sight.

(*b*) Pressure on the recurrent laryngeal nerve causes alteration of the voice, sometimes dyspnœa.

(*c*) Pressure on the œsophagus may cause slight trouble on deglutition, but great difficulty is uncommon.

(*d*) The great vessels are pushed backwards by simple goitres, but encircled by the malignant forms.

Signs. The physical signs are usually sufficiently characteristic ; in most examples the enlargement can be made out to be in the position of the thyroid, even if the shape be indistinct. The fact that it rises on swallowing owing to its attachment to the trachea and larynx is fairly conclusive ; but

it should be noted that a goitre may become too fixed by past inflammation to its surroundings to move on swallowing, while other tumours, *e.g.* tuberculous glands, are occasionally adherent to the trachea and move with the latter.   It is usually possible to detect by palpation whether the condition is a local tumour (adenoma) and whether it is cystic ; it should be noted, however, that sometimes one half is congenitally absent, and the physiological enlargement of the only lobe may be taken for an adenoma ; removal of this would be serious.

Treatment. This depends partly on the nature of the goitre and partly on its effects. Adenomas should as a rule be removed, since they grow indefinitely and are liable to sudden increase in size from hæmorrhage, causing urgent or fatal pressure on the trachea. In occasional examples, where the adenoma has been present for years, forming a large cyst projecting outwards without signs of pressure, it may be left alone unless removed for cosmetic reasons, and it may fairly be doubted whether such operations are justifiable ; at any rate, it is not for the surgeon to urge them.

Where the goitre is parenchymatous, removal of the cause will cure in the early stages, viz. by removing the patient from the infected water-supply or boiling the water, and administering intestinal antiseptics (thymol). Iodine and iodides are well reputed, and thyroid extract may be advisable where

Fig. 165A. Large adenoma of the thyroid of many years' duration with cystic degeneration.

signs of myxœdema appear. When, however, the goitre is producing signs of pressure, operation is indicated as well as where the tumour is of some size or medical measures produce no effect, since, even if stationary, the constant pressure on the trachea will cause atrophy of the cartilage and collapse of the tube. Another indication for operation is where, with or without signs of pressure, there is evidence of hyper-thyroidism, as shown by rapid pulse, tremor, &c. (*see* Hyper-thyroidism, p. 494).

Indications for Operation. (a) Most cases of adenoma : as the diagnosis of adenoma cannot always be made on physical signs, some cases will be found to be adenomatous at operation which were supposed to be parenchymatous, thus explaining their want of reaction to medical treatment.

(b) Any form of goitre producing pressure on the trachea, causing dyspnœa on slight exertion, paroxysmal dyspnœa, tracheal stridor, or narrowing of the trachea as seen with the laryngoscope.

(c) Where the goitre presses on the large vessels and causes giddiness on stooping, sleeplessness, &c.

(d) Where the goitre is pressing on the œsophagus.

(e) Where the goitre is substernal.

(f) Steady increase of the goitre in spite of medical measures.

(g) In acute cases, where respiratory embarrassment may suddenly arise, as it is far safer to operate before this takes place, since the difficulty is much increased where the case is urgent, from the speed necessary and the size of the distended veins.

Operations. The most generally useful is removal of half the gland with the isthmus, but enucleation of adenomas is good practice in selected cases. Other operations which have been employed but hardly need more than mention are :

(a) Division of the isthmus, for cases where enlargement of the lateral lobes presses on the trachea laterally. This has been done as an emergency, but the relief afforded is slight ; much better is it to remove one lobe.

(b) Exothyropexy consists in exposing the gland and dislocating half into the wound when it dries and atrophies ; but hæmorrhage is likely to occur and extra pressure on the trachea from twisting the gland.

Removal of Half the Gland ; Partial Thyroidectomy. In most cases open ether may be given as the anæsthetic, following injection of morphia gr. $\frac{1}{4}$ and atropin gr. $\frac{1}{100}$, given an hour before ; but where there is much dyspnœa local anæsthesia with novocain will be safer.
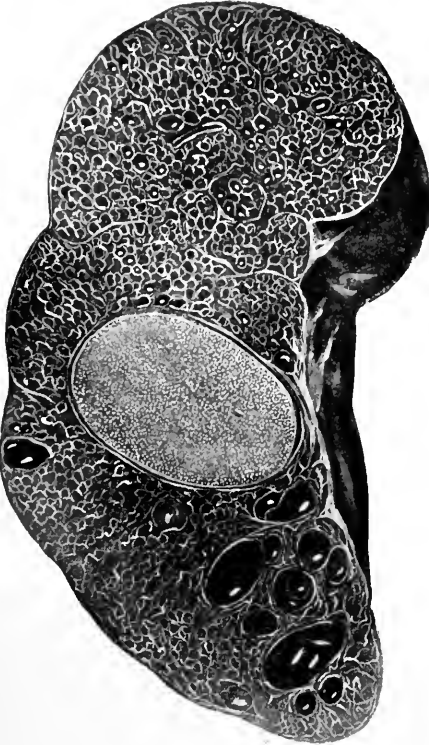
Fig. 166. Section through a goitre. In the upper part the structure is almost normal, but the vesicles are enlarged and distended with colloid. In the middle is seen a well encapsuled adenoma of homogeneous structure, colloid being absent from the acini (this condition is also found in exophthalmic goitres). In the lower part the distension of the vesicles is greater, so that cysts are formed in places.

Operation. The patient is in the dorsal position with the head extended, and a horizontal incision is made over the greatest prominence of the growth, tailing up at its extremities (the collar-incision) ; where, however, the tumour is substernal the incision should be transverse over the larger part of the swelling and then turn down to the episternal notch (Kocher's angled incision). The skin is reflected, the cervical fascia divided, and the sternothyroid and sternohyoid muscles divided as far as necessary, exposing the thyroid gland.

The upper pole on the side most affected is then traced upwards and outwards and the superior thyroid vessels tied and divided. The front of the tumour is freed and the isthmus divided between clamps. Attention is then directed to the lower pole (this is easier if the isthmus be divided first and the gland partially dislocated forwards and downwards) : it is best not to remove the whole lower lobe with its capsule but to clamp inside the latter and then divide ; in this way the recurrent laryngeal nerve will surely escape injury and at least one parathyroid will be left on that side. (The possibility of these small structures being of importance has been mentioned, and as they can readily be left, it seems reasonable to do so.) During the process of freeing the tumour all large veins, which are often abundant, should be divided between forceps or ligatures. In this way bleeding becomes negligible, but if attention be not paid to this point severe bleeding will endanger the patient's life and render the operation very difficult. Drainage with a tube should be maintained from the depths of the wound for thirty-six hours and the muscles and skin sutured. Drainage is needed in cases of thyroid intoxication from absorption by the raw surfaces, and for this reason the gland should be handled very gently to avoid forcing the secretion into the lymphatics. Where the goitre is substernal careful dissection with blunt elevators will be needed, and possibly tapping of cysts to render its delivery possible.

Operation in Cases with Urgent Dyspnœa. This arises in cases of acute goitre or of bleeding into cysts. The operation must be speedy and there is little gained by dividing the isthmus, unless as a preliminary to removing the largest half of the gland, as above. Where the condition is still more urgent the best plan is to perform laryngotomy and push a gum-elastic catheter or similar instrument past the obstruction and then remove the half-thyroid, as low tracheotomy is difficult in these cases and likely to be followed by infection of the mediastinum, pneumonia, &c. (Jacobson).

Evacuation of a cyst when filled with blood may be of great assistance.

Enucleation of Adenomas. This is suitable for superficial, single growths ; where adenomas are deeply placed removal of half the gland is better, as enucleation may lead to troublesome hæmorrhage. Enucleation is also indicated where the other half of the gland is atrophic, where there is no general enlargement of the thyroid, and where the thyroid is very adherent to surrounding structures.

Operation. The skin and muscles are divided by a collar-incision as before and the tumour investigated. If it prove to be superficial, the thinned gland substance over it is divided and the adenoma enucleated by blunt dissection ; sutures are passed into the wall of the cavity to pucker it together and prevent hæmorrhage. Should hæmorrhage occur and difficulty arise, it will be best to pack the cavity full of gauze and proceed with removal of half the gland.

(*b*) MALIGNANT TUMOURS OF THE THYROID. These are usually cancers, occasionally sarcomas, and seldom occur before fifty. These tumours may originate in normal thyroids or in goitres.

Signs. The growth is rapid, hard, irregular, encircling the large vessels and not pushing these on one side. Owing to the early fixity to its surroundings, mobility on swallowing is often missing, involvement of the recurrent laryngeal nerve with hoarseness or dyspnœa is frequent, while hæmoptysis from invasion of the trachea is fairly common.

Involvement of the cervical glands takes place early, as do metastatic deposits, especially in the bones of the skull.

Diagnosis. From simple goitres the irregular hardness, fixity, and involvement of nerves and vessels, as well as the glandular and bony metastases, usually distinguish. There may be some difficulty in discriminating between calcification in an old goitre and malignant changes in such a goitre ; exploration will often be safest in such cases.

Treatment. Removal is only possible in the early stages, and these cases often come for advice too late. Where fixity to the trachea, involvement of vessels and nerves, or hæmoptysis is present operation is out of the question, except perhaps palliative tracheotomy, which may be difficult from the displacement of the trachea : an intratracheal prolongation of the tracheotomy-tube will often be needed.

Fig. 167. Thyroid in Graves's disease (magnified). Note the absence of colloid and increase in numbers of the secreting cells. (Mr. A. J. Walton's case.)

(c) Goitre with Hyperthyroidism ; Graves's Disease and its Allies. The most marked examples of this condition are described as Graves's, Basedow's, or Parry's disease, but a large number of cases are found in which some of the signs of hyper-thyroidism are present associated with goitre, and may well be designated *hyper-thyroidism* or *thyrotoxicosis* : according to Berry the minor forms do not necessarily run the extreme course noted in the well-marked cases of Graves's disease, but the underlying trouble seems in all to be due to the same excessive absorption of thyroid colloid, and it is therefore reasonable to group them together.

The ætiology is obscure ; the best-marked examples are considerably more common in women than in men, and usually commence between twenty and thirty years of age. Overwork, worry, shocks, &c., are put down as causes, but these are probably more noted in patients whose nervous equilibrium is upset by thyroid poisoning than in the normal individual, and so can hardly be regarded as causes.

Anatomy. The most noticeable thing about the thyroid in well-marked instances is the absence of colloid from the vesicles, together with a prolifera-

tion of the epithelium of the acini, which gives the gland a homogeneous appearance, quite different from the honeycomb-like effect of ordinary thyroid tissue. This is not because the colloid is not produced, but because it is absorbed, as soon as it is formed, into the lymphatics. There is no increase in the vascularity of the gland (Berry), though this would appear to be the case clinically ; the pulsation noticed is chiefly transmitted from the bounding carotids, which show the low blood-pressure characteristic of the disease. The gland is enlarged, but not greatly, and the amount is trivial compared with that found in many simple goitres ; the enlargement affects the whole gland.

Signs. The condition of well-marked Graves's disease (exophthalmic goitre) is distinguishable at a glance. The wide palpebral fissure (Stellwag's sign, due to retraction of the upper lid), the exophthalmos (due to excess of orbital fat—Von Graefe's sign), the unwinking gaze and failure of the upper lid to follow the eyeball when the latter moves downward, form a clinical picture which, with the moderate goitre, tachycardia, fine

Fig. 168.   Section of colloid goitre (magnified).

tremor and nervous manner, can hardly be missed or confused.

Anæmia, emaciation, and slight fever are common, as well as pigmentation of the skin. In severe cases the mental state borders on insanity, the protrusion of the eyeball and the want of covering from the lids leads to corneal ulcers and destructive panophthalmitis, while diarrhœa still further debilitates the patient. Death from pneumonia is a frequent ending in the advanced cases. Dilatation and hypertrophy of the heart, with degeneration of heart and vessels, follows in consequence of the toxæmia and increased action of the heart. Similar symptoms are produced by prolonged overdosing with thyroid extract.

In addition to the classic examples of the above type, considerable numbers of patients are found in whom there is tachycardia and tremor with goitre, possibly nervousness, cardiac changes and diarrhœa, and it seems not unreasonable to regard these as of similar nature to Graves's disease but of minor degree : these cases improve rapidly on removal of half the gland.

As regards Graves's disease, a certain number of cases recover (in time) on medical treatment or nothing, others drag on as confirmed invalids, while in a very considerable percentage the course of the disease is progressively downwards and death occurs in a few months. From published accounts the prognosis is not easy to give, but the disease must be regarded as most serious.

As regards mortality, Hayle White gives this as twice that of ordinary individuals, but only half the cases were traced in his series. Hector Mackenzie considers that 25 per cent. are cured by medical treatment, 25 per cent. relieved, 25 per cent. remain chronic invalids, and 25 per cent. die of complications, *i.e.* 50 per cent. are useless as wage-earners under medical treatment. Moreover, where cure results from medical or expectant treatment it may take years, which is not good for nervous patients.

Treatment. In early and slight cases complete rest and sedatives may be tried with applications of X-rays to the thyroid. The milk of thyroidectomized goats has been used with little result. Where the above measures fail to cure after a fair trial, or where the condition is advancing in spite of treatment, surgical measures should be

Fig. 169. Exophthalmic goitre. (Mr. Walton's case.)

adopted. The mortality which used, so unfortunately, to be associated with this disease was largely due to physicians waiting too long before permitting surgical intervention ; for where the patient is failing from prolonged toxæmia and cardio-vascular degeneration the operation naturally becomes increasingly hazardous. The more enlightened counsels of the present day result in a far smaller mortality. Thus in the hands of Kocher, Dunhill, and Mayo it varies from nil to 3 per cent. Operators with smaller experience give mortalities up to 10 per cent., which is far better than the results of medical treatment, to say nothing of the greatly increased rapidity of cure ; while as regards cure Fuller gives for a large number of cases 85 per cent. cures after operation, in most of which the result was obtained soon after operation. The mortality should certainly become less with more experience (as shown by the results of those who

have had the most practice), and it is important to choose the best time to operate. The operation should not be done when the intoxication is at its height, which, according to Plummer, is between six and twelve months after the onset. The mental excitement and muscular weakness give some clue to the amount of intoxication. Dilatation of the heart over one inch outward is dangerous. Great excitement and weakness, bronchitis, mania, albuminuria and diarrhœa, irregular pulse, and very low blood-pressure should lead to postponement of operation till these conditions are improved by rest and medical attention. Where these conditions persist operation is hardly worth considering.

The operation usually to be adopted is removal of half the thyroid, as already described for simple goitre, taking special care not to handle or bruise the gland. In severe cases it may be safer to ligature one superior thyroid artery and a week later remove the half-gland on the opposite side. When removal of half the gland is not sufficient a good part of the other may be removed later, but on no account should the whole gland be removed.

After operation there is usually some reaction, the pulse becoming more rapid for a short time, but gradually quieting down and sinking to much below the former rapidity. The subjective results are, in many instances, better than the objective, *i.e.* patients in whom exophthalmos, with some tachycardia and tremors, persist feel far stronger and can carry out their ordinary duties.

With regard to the anæsthetic, open ether is advisable in most instances ; some surgeons employ local anæsthesia, but this seems hardly commendable with such nervous patients. Atropin and morphia should be given first, and if ether in olive oil be administered per rectum the patient may be anæsthetized unawares (the thyroid thus being stolen after Crile's suggestion), and once under, the anæsthetic may be continued by mouth in the ordinary manner. Where the reaction is severe plenty of saline should be infused per rectum and subcutaneously, and morphia may be needed for restlessness.

SECTION VII

THE GENITO-URINARY SYSTEM

CHAPTER XXXII

INTRODUCTION TO GENITO-URINARY SURGERY

General : Examination of Urinary Cases : Symptoms : Urine : Abnormal
Constituents : Sources of Blood and Pus : Radiographs : The Cystoscope :
The Ureters : Pyelography : Renal Function : Anuria : Instrumentation and
Urinary Asepsis.

THE genito-urinary tract, kidneys, ureters, bladder, testes, epididymes
vasa, and urethra are developmentally, physiologically, and pathologically
so intimately connected as to form a very distinct group from a surgical
standpoint.

The kidney and testes are formed from closely related portions of meso-
blast, with the result that their blood- and nerve-supply come from practi-
cally identical sources, while the lymph-drainage in both instances reaches
the same goal. The bladder and urethra are developed from the hind-gut
and cloaca respectively ; the vas and ureter are serially homologous struc-
tures, being the past and present ducts of the excretory organ in the course
of its development. To take examples, tuberculosis of the genital and
urinary portions of this system is intimately connected, while venereal,
i.e. genital disease, has a far-reaching influence in the urinary organs proper.
The genito-urinary system must be examined as a whole, for disease in
one part often produces symptoms and sequelæ in another, *e.g.* early tuber-
culosis of the kidney may present as its sole symptom nocturnal frequency
of micturition. A major part of the disease may be missed unless the
whole system be examined in a painstaking and logical manner. Thus it
is fatuous to remove a stone from the bladder only, when perhaps new
stones are constantly passing down the ureter to take its place, or to drain
or cauterize an ulcerated bladder, while the main lesion is advanced tuber-
culosis or cancer of one kidney.

EXAMINATION OF URINARY CASES

Note should be taken of :

(1) The onset and principal complaints, whether they are intermittent
attacks (as often with stone and movable kidney) or continuous (as in cases
of new growth or tubercle).

(2) As to *pain*, (a) whether in the loins, hypogastrium, penis, or testis.

(b) Whether it radiates, *e.g.*, from the loin to the testis, which is very suggestive of a renal origin.

(c) Its relation to micturition or movement, the latter suggesting stone ; or if relieved by recumbency, as in pain from mobile kidneys.

(d) The character of the pain, whether very severe and paroxysmal, causing faintness and vomiting and, in fact, being " colic."

(3) The venereal history ; *e.g.* the history of past gonorrhœa, gives a reason for stricture, etc.

(4) Family history of tubercle, or gout which will suggest stone.

(5) General signs, especially as throwing light on the renal condition.

(a) *The Alimentary System.* Thirst, loss of appetite, vomiting, constipation, all point to renal inadequacy.

(b) *The Nervous System.* Fits and headache also suggest deficient renal function.

(c) *The Respiratory System.* Chronic cough, night sweats, tubercle bacilli in the sputum, which suggest the possibility of genito-urinary tuberculosis.

(d) *General.* Wasting, rigors, fever, œdema, which suggest failing kidney or renal sepsis, &c.

(6) THE URINE. (a) The manner of micturition should be actually seen and the stream noted : a weak dribble points to urethral obstruction ; if improved by straining it is probably due to a stricture, but if made worse by this proceeding, more likely from an enlarged prostate.

(b) Failure to micturate from *retention*, *i.e.* obstruction to the outflow, or *suppression* when no urine is secreted. Incontinence or inability to control the flow.

(c) Increased frequency of micturition may be due to disease of the bladder (cystitis, enlarged prostate) or of the kidney (tuberculosis).

(d) The amount of urine passed daily will give some idea of the renal condition, while its specific gravity and urea percentage will give further clues on this matter.

(e) *Abnormal Constituents of the Urine.* Under the heading Renal Function is discussed the meaning of the quantities of the normal constituents. The abnormal matters are either dissolved in the urine or suspended and tend to form deposits. Soluble matters are albumen and sugar.

(1) *Albuminuria.* The presence of albumen in the urine indicates some defect in the renal epithelium, transient or permanent, and its presence renders further investigations necessary before operations other than those of urgency are undertaken. The presence of albumen is detected by boiling slightly acidulated urine, when a white flocculent precipitate of coagulated albumen forms. The albumen may also be precipitated by adding strong nitric acid. Albumen is found in the urine in (1) cyclical albuminuria, (2) renal disease, (3) cardiac disease with back pressure, (4) lardaceous disease.

(2) *Glycosuria.* The presence of sugar in the urine is suspected when the specific gravity is over 1025, and proved by the brown precipitate formed on boiling with " Fehling's solution " and by fermenting with yeast. In

such urine acetone and diacetic acids are also found. The danger of coma from "acidosis" or aggravated sepsis has been mentioned in an earlier section (vol. i, p. 118).

INSOLUBLE ABNORMALITIES IN THE URINE. These may be saline deposits, or organized such as blood, pus, casts, micro-organisms, &c.
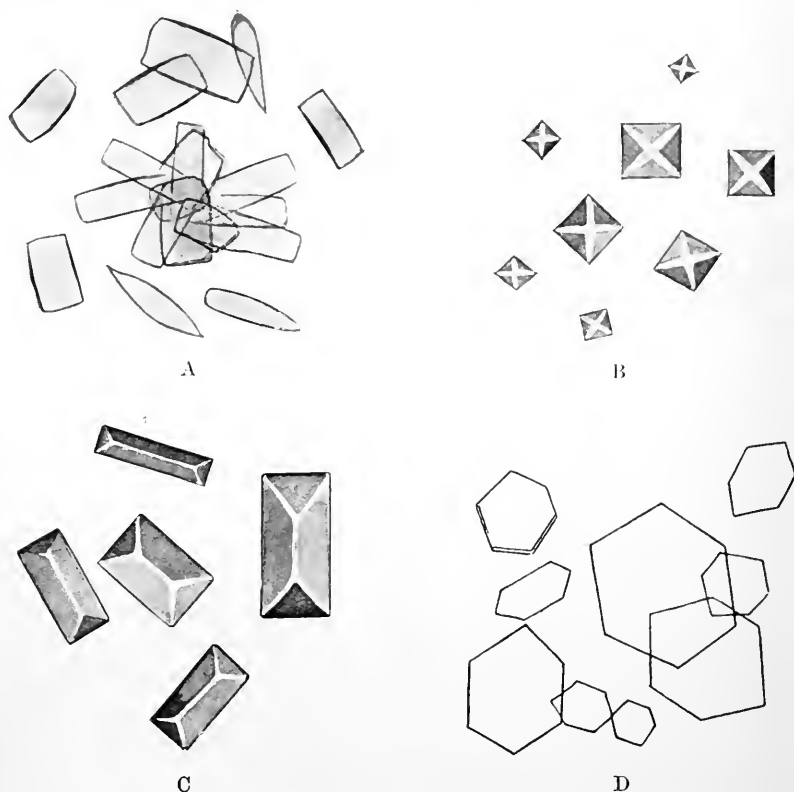
FIG. 170. Crystals found in urine. A, Crystals of uric acid (magnified). B, Crystals of oxalate of calcium (magnified). C, Crystals of triple phosphate (magnified). D, Crystals of cystin (magnified).

The precipitation of salts depends not only on the amount present but on the degree of acidity or alkalinity of the urine.

A. Deposits in acid urine are uric acid, urates, and oxalates.

(1) Uric acid is deposited in highly acid urine in the form of " cayenne-pepper " crystals, the shape of which is elongated rhomboids, whetstones, or needles, highly coloured by urinary pigment ; these form the " gravel " of gouty subjects.

(2) Urates, " lithates," are found in urine after it cools as amorphous deposits or in the form of small spiculated globules (ammonium urate). Urates are dissolved on boiling or addition of alkalis.

(3) *Oxalates.* Calcium oxalate occurs as a deposit in the urine of children, dyspeptic and anæmic patients, and are supposed to be due to excess

of oxalates in the food, *e.g.* from eating rhubarb. The crystals are flat, octahedra or dumb-bell-shaped and soluble in alkalis.

B. *Deposits in Alkaline Urine.* These are of various sorts of phosphates, all soluble in dilute acids and precipitated by boiling, and so likely to be confused with albumen, but being soluble on adding acetic acid, are easily distinguished.

Varieties of Phosphates. (1) Triple or ammonio-magnesium phosphate occurs in crystals of the knife-rest or coffin-lid type, and always where decomposition of urea is taking place.

(2) Amorphous calcium phosphate may occur normally when the urine is alkaline after a meal of vegetables, causing the urine to appear milky and frighten the patient, who thinks he is passing semen.

ORGANIZED ABNORMALITIES IN THE URINE. *Blood* when present in large quantities is easily detected by its red colour, but this must not be confused with the red urine found in fever with high specific gravity and excess of urates. Blood in small quantities gives the urine a smoky colour, the smoke being of the orange tint of a London fog. The presence of blood corpuscles is detected with the microscope ; the spectroscope shows hæmoglobin, but this may be present without corpuscles in the condition *paroxysmal hæmoglobinuria.* A rough test is to shake the urine with tincture of guaiacum and ozonic ether ; on standing, the ether will float on the top and appear blue if blood be present.

Pus forms a whitish deposit : unlike phosphates (with which it may be confused), it is insoluble on boiling, and may be recognized by the microscope or by shaking it with liquor potassæ, when the urine becomes ropy.

Casts of *renal epithelium,* as well as of blood and hyaline material and desquamated epithelium of bladder, vagina, &c., appear in the urine and are recognized on microscopical examination.

Chyle is rarely found, from back-flow of chyle in filarial conditions and rupture of the vesical lymphatics. The urine appears milky, and under the microscope fine, highly refractile globules of fat are seen.

The presence of *micro-organisms* is detected by microscopic examination of fresh or stained specimens, and in difficult instances after centrifugalizing, or by inoculation into media or animals : where the organisms are very numerous they may form turbidity or opalescence of the urine, especially when they belong to the colon group.

(7) PHYSICAL EXAMINATION. (*a*) The penis is examined, noting any congenital malformation such as hypospadias, which suggests the possibility of abnormality higher up, such as congenital stricture of the urethra, absence of one kidney, &c. There may be discharge of pus from the meatus, various inflammations about the glans and prepuce, while indurated strictures may be felt on palpating along the course of the urethra.

(*b*) The testes and scrotum show present and past disease of the testis, usually tuberculous or gonorrhœal, and give a clue to the condition elsewhere in the kidney or bladder ; while fistulæ will point to some urethral obstruction.

(c) The abdomen is examined for enlargement of the kidney or bladder, as well as superficial or deep tenderness.

(d) Rectal examination reveals the condition of the prostate and vesiculæ, while the base of the bladder can be palpated bimanually in children and stones detected.

(e) Examination of the urine has been mentioned as regards abnormal constituents; in addition to noting these, it is most important to find whether the substance in question (blood, pus) comes from the kidney, bladder, or urethra. The following points will give some clue:

(1) Blood coming from the urethra (usually due to injury or acute gonorrhœa) drips persistently from the meatus, quite independently of micturition, and is unaltered in character.

(2) Blood derived from the bladder-wall (injury, ulceration, stone, growth) is passed only on micturition and is generally found in greater quantities at the end of micturition, the last portion being often practically pure blood. Clots, when present, are large and irregular and may block the urethra, causing "clot-retention."

(3) From the kidney, blood is passed intimately mixed with the urine. If in small quantity the latter appears "smoky"; when in larger quantity the urine is porter-coloured from changes caused on the blood by the urine; where the bleeding is free the urine may be bright or dull red, and any clots are like strings, tapes, or macaroni from being formed in the ureter: such "ureteric casts" are diagnostic or bleeding from the kidney.

SOURCES OF PUS IN THE URINE. This is ascertained by irrigation of the urethra and the "two-glass test." The urethra is irrigated by means of a catheter and funnel, the former being passed to the compressor-urethræ and the urethra washed out with boric lotion. This wash will contain pus, threads, &c., from the anterior urethra. The patient is then directed to pass urine into two glasses, an ounce into the first and the remainder into the second. The first glass contains the washings from the posterior urethra; any pus in the second comes from the bladder or kidney. Pus in the posterior urethra may come from the urethra or vesiculæ and prostate; to settle the latter point the bladder is washed out till the lotion comes back clear and left full of lotion; the prostate and vesiculæ are then massaged per rectum to express any pus and the bladder voided once more, when any pathological secretion massaged into the posterior urethra will be washed out. In this manner the origin of pus is traced to the anterior or posterior urethra and the vesiculæ and prostate.

To settle whether the pus from the bladder comes from the latter or from the kidneys the cystoscope is needed, examining the orifices of the ureters and watching for discharge of pus from one or both. A rough idea can be formed of the origin of pus, whether from the kidney or bladder, as follows: The urine is allowed to stand in a test-glass; in a few hours pus from the kidney will settle in a distinct layer at the bottom with a well-marked upper limit, while pus from the bladder tends to remain disseminated through the specimen and the upper limit is not clear.

Special examinations are made by means of X-rays and cystoscopic methods.

(8) The X-ray is a most valuable method for examining cases of urinary disease. In these cases skiagrams are taken of the kidney, ureter and bladder, and will show the presence of stones ; good plates will show the position and size of the kidney. Pure uric-acid stones are transparent (few stones are quite pure). Solid fæces may throw a shadow ; hence the bowels should be well evacuated before the examination is made, and repeated examinations are advisable where there is any doubt, as fæcal masses will shift, while stones may be observed to pass along the ureter :
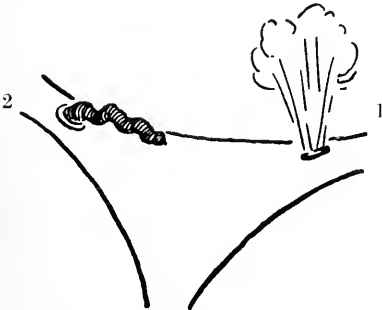
FIG. 171.   Efflux from ureters as seen with the cystoscope. 1, Normal efflux. 2, Semisolid worm-cast of pure blood coming from a patulous ureter.
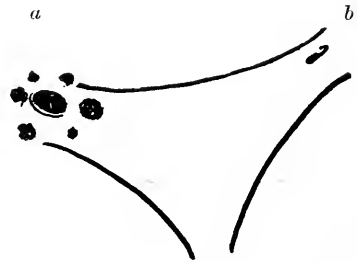
FIG. 172.   Cystoscopic view of trigone. *a*, " Golf-hole " patulous ureter surrounded by ecchymoses. *b*, Normal ureter.

it should be noted that calcified glands and calcification in veins (phleboliths) give very definite shadows.

(9) The *cystoscope* is of the greatest value, as with its help the interior of the bladder can be readily inspected.

This instrument consists of a " cold " lamp set at the end of the examining tube, which is bent an inch and a half from the lamp to form a " beak " and is of size equal to a 14-catheter, or smaller for children.

Where the beak joins the main tube is an aperture containing a prism. The rays of light shed from the lamp on part of the bladder are reflected on the prism, and by this refracted up the tube to the eye of the observer, and by rotating the instrument portions of the whole bladder may be seen in turn.

To use the cystoscope the bladder must contain clear fluid, and where the urine is clear the patient is given Contrexeville water an hour before the examination is made, when the bladder will contain a sufficiency of clear urine. Where the urine is turbid with blood or pus, the bladder is washed out till quite clean with boric lotion or solution of oxycyanide of mercury 1 in 5000. The bladder should contain four to ten ounces of liquid, according to its size, before the instrument is introduced, and the urethra should be anæsthetized with 4 per cent. novocain or a general anæsthetic employed. The cystoscope gives information about the wall of the bladder,

and by observing the ureteric orifices inferences may be drawn about the condition of the kidneys.

(a) The wall of the bladder is examined for inflammation, ulcer, growth, diverticula, rupture, stones and foreign bodies, &c.

(b) The normal ureteric orifice is a small slit usually straight but fairly often curved or like a horse-shoe, and at intervals of half to five minutes a wave of peristalsis passes along the adjacent bladder to the orifice and a gush of clear urine is emitted. The orifice may be œdematous and puffy or dilated and patulous even to the extent of becoming a circular pit (golf-hole ureter), and there may be ecchymoses about the orifice, all of which point to changes in the kidney or ureter above, caused by stones, pyelitis, nephrectasis, &c. The efflux of the ureter should also be noted, as to whether it be clear urine or tinged with blood or pus, consisting of pure blood, or whether there be no proper efflux at all but only the drooling of inspissated pus (resembling worms' earth) coming from a dilated golf-hole ureter and pointing to gross disorganization of the kidney (Figs. 171, 172).

Fig. 173. Pyelograph or radiogram of the renal pelvis and ureter filled with collargol through a ureteric catheter.

(*Kindly lent by Dr. Gilbert Scott.*)

The ureteric efflux may be more easily studied after injection of 5 c.c. of a 4 per cent. solution of indigo-carmine into the muscles of the buttock.

This should appear as a blue efflux from the ureters after fifteen minutes, and if this does not appear for thirty minutes or only as a faint green discoloration, the kidney or kidneys thus affected are deficient in function.

This method affords a valuable clue when considering the question of removing the kidney (especially in emergencies, as it takes but little time), as it shows pretty clearly whether the affected kidney is worth retaining and also whether the other kidney is up to its work.

Finally, with the help of the cystoscope the urine may be collected separately from each kidney. The catheterizing cystoscope contains, besides the visual tube, another small tube, down which a ureteric catheter (of No. 1 size and double length) can be inserted and, by a suitable mecha-

nism, worked by a screw near the eye-piece, manœuvred into the ureter. In this manner small quantities of urine are collected from each kidney separately and examination made as regards its content of salts, urea, and the presence of organisms, above all of the tubercle bacillus.

Collargol (5 per cent.) may be injected into the kidney through such a catheter and radiographs taken (pyelography) (Fig. 173), which will show the size of the renal pelvis, position of the kidney, and may afford useful help in the diagnosis of obscure abdominal tumours and of detecting the presence of absence of one kidney, &c., while the presence of the opaque collargol in the ureter will help to decide whether shadows along the ureter are of stones or due to objects outside the latter ; radiography, after introducing opaque bougies (containing iron-oxide), may be employed for the latter purpose.

The use of the segregator (Luys) for collection of the urine of each kidney is not advised, as it is not very accurate and is liable to get out of order inside the bladder, when its removal becomes very difficult, not to say dangerous.

RENAL FUNCTION

The power of the kidneys to resist the shock of an operation is of importance in all such cases, but is of particular moment when the question of removing one kidney arises.

Symptoms pointing to deficient power of renal excretion are : thirst, loss of appetite, a furred tongue, wasting, constipation, anæmia, and alterations in the urine, as follows :

(*a*) Where the renal function is depressed the *amount* of urine passed daily is at first above the normal average of fifty ounces (the specific gravity being lowered), but later tends to diminish till complete suppression or anuria takes place.

(*b*) The *specific gravity* is diminished in cases of renal failure, and when below 1008 for several days, independent of the amount of fluid ingested, the kidneys must be regarded as in a serious condition and such operations as prostatectomy to be approached with caution or avoided.

(*c*) A fall in the *percentage of urea* below 1·5 per cent. is also a danger-signal. It is essential in making these estimations to have the whole quantity of urine passed in the twenty-four hours collected and measured, as an increased percentage of urea may be excreted in a diminished amount of urine, so that the total excretion is really much diminished, which would not be suspected from merely taking the percentage of urea in the urine.

(*d*) Finally, there are methods of estimating the *total saline-content* of the urine as compared with the blood ; this is done by estimating the electrical resistance of the serum and that of the urine : the numerical relation of these is called the " hæmorenal index," and when this is lowered the renal function must be under suspicion.

(*e*) The simplest of the more exotic methods is the *indigo-carmine test*, and consists in collecting the urine by catheter every fifteen minutes after injection into the buttock, as previously described ; if not appearing

for more than thirty minutes the renal function is below normal, and the longer the blue colour is absent the worse is the condition.

The electrical method can be applied to small quantities collected from each kidney with the ureteric catheter and gives some indication of the values of each kidney, but the indigo-carmine test is simpler and equally efficacious.

ANURIA OR SUPPRESSION OF URINE. This is the final stage of impaired renal function, the kidney ceasing to secrete any more urine, and may result from operations or disease. This must be distinguished from *retention*, in which the urine is secreted but cannot be voided from the bladder.

Anuria may be obstructive or non-obstructive in origin.

(1) Obstructive anuria is due to the blocking of the ureter of the acting kidney (the other being absent or put out of action by previous disease), and is usually due to calculus, but clots and kinks may cause this.

(2) Non-obstructive anuria is caused by :

(*a*) Inflammation, whether microbic or toxic, as in severe pyelonephritis or acute Bright's disease (nephritis).

(*b*) Reflex action, usually from interference with the urinary tract, *e.g.* instrumentation, proctatectomy, &c., and almost always in cases where the renal function has already reached a low ebb. The suppression found in ordinary shock is of this nature.

Apart from operations, anuria of sudden onset is probably obstructive, and usually due to a calculus in the ureter of the acting kidney. Investigation with X-rays is necessary and exploration of one or both kidneys, as described under Calculous Anuria (p. 533).

When anuria develops after operation and in conditions of renal disease it is often incomplete (better called oliguria) and often due to low blood-pressure ; hence intravenous saline infusions, digitalin, adrenalin, and pituitary extract should be given.

For the anuria of acute nephritis (Bright's disease), purging, bleeding, and saline infusions, with hot packs and injection of pilocarpin gr. $\frac{1}{10}$, are of service. Where these measures are inadequate the kidneys may be rapidly exposed in the loin (Edebohls) and the capsule incised and stripped. This appears to have been successful in some instances, the idea being that free opening of the capsule relieves the pressure on the congested and œdematous renal parenchyma.

INSTRUMENTATION AND URINARY ASEPSIS. Asepsis in urinary surgery is of paramount importance owing to the serious results which may follow from errors in technique, and lead to cystitis, renal infection, &c., and a few words on the use of urethral instruments will not be out of place. Catheters are made of rubber, gum-elastic, and metal ; bougies of steel, gum-elastic, catgut, whalebone, &c.

To prevent lodgment of bacteria, the surface of catheters and bougies should be perfectly smooth, and catheters should be smooth inside as well as outside ; further, they should be solid beyond the eye ; any rough catheters or bougies should be dismissed at once.

Sterilizing Urethral Instruments. Catheters, after use, should be washed in hot soda lotion (metal instruments boiled), washed inside and out with spirit, and dried. Soft catheters should be boiled before use. Gum-elastic instruments may be placed in boiling water for a few minutes before use, but this treatment soon destroys them. Such instruments should be exposed to dry formalin vapour, either placing them for twenty-four hours in a closed box at the bottom of which is a solution of formalin 40 per cent., or they may be exposed to the action of hot formalin-vapour in a special oven for half an hour. A simpler plan is to leave them in a solution of corrosive sublimate (1 in 1000) for twenty-four hours, dry with a sterile cloth, and keep in a sterile tube. Cystoscopes are sterilized by the formalin method. As lubricants, olive-oil or parolein, sterilized by boiling, should be used for catheters and bougies ; while for cystoscopes boiled glycerine is needful, since oil fogs the glasses.

Passage of Instruments. The hands of the surgeon and the penis of the patient should be well cleansed with antiseptic lotions and the anterior urethra washed out with solution of oxycyanide of mercury (1 in 5000) and the sterile instrument gently inserted till the bladder or obstruction is reached. To pass a silver catheter, steel bougie or cystoscope, the patient lies on his back ; the surgeon, standing on the right side, introduces the catheter into the penis in line with the right Poupart's ligament. As the catheter passes down the handle is brought into the middle line close to the abdominal wall, and as the end of the instrument passes the triangular ligament the handle is raised to the vertical position and then depressed between the legs of the patient. The last manœuvre is sometimes difficult owing to the triangular ligament and spasm of the compressor-urethræ. The penis should be pulled well down the catheter and the point kept to the floor of the urethra as the triangular ligament is passed, but to the roof after this obstacle is overcome, and there will seldom be much difficulty. Of gum-elastic catheters the most useful types are the olive-headed and coudé, while of steel bougies the type of Buckston Brown is more handy than that of Lister. As regards size, the French scale denotes the circumference of the instruments in millimetres ; the English scale is arbitrary, and the instruments are, roughly, double the size of French instruments bearing the same number.

For the difficulties and dangers of instrumentation, including " catheter fever," the reader is referred to the section on " Urethral Stricture " (pp. 539, 618–620).

CHAPTER XXXIII

SURGERY OF THE KIDNEY

Anatomy : Exploration of and Operations on the Kidney : Congenital Defects :
Injuries of the Kidney and Ureter : Movable Kidney : Renal Calculus : Ureteric
Calculus : Calculous Anuria : Hydronephrosis, Pyonephrosis : Infections of
the Kidney : Catheter Fever : Bacilluria : Fulminating, Infective Nephritis :
Pyelitis : Pyelonephritis : Abscess of the Kidney : Perinephritis : Renal Fistula :
Renal Tuberculosis : Syphilis : New Growths : Polycystoma : Malignant
Tumours of Adults, of Infants : Cysts of the Kidney.

Anatomy. The kidney is situated opposite the last dorsal and three
upper lumbar vertebræ, the hilum being on a level with the disc between
the first and second. Behind, the kidney is applied to the diaphragm and
the arcuate ligaments (hence its movement on respiration), while lower down
the quadratus and transversalis muscles are posterior relations. The last
dorsal, ilio-inguinal, and iliohypogastric nerves pass down and outward
between the kidney and the last-named muscles, and must be avoided in
exploring the organ from behind. In front of the right kidney are the liver,
suprarenal capsule, and hepatic flexure of the colon ; while in similar rela-
tion to the left kidney are the stomach, spleen, suprarenal capsule, splenic
flexure of the colon, and a coil of small intestine. The kidney lies in a loose
sheath of areolar tissue, the meshes of which are filled with fat (the fascia
of Zuckerkandl or Gerota), and which is in part covered with peritoneum.

Examination. The general methods of investigating renal disease are
discussed in the last chapter ; an enlarged kidney or renal tumour presents
the following signs :

(1) The shape is ovoid, without edges, which distinguishes it from
enlargements of the liver or spleen.

(2) The tumour goes back into the loin, *i.e.* with one hand in front and
the other behind the mass can be grasped and pushed from one against the
other.

(3) The tumour moves on respiration, though less than do the liver and
spleen.

(4) The expanding viscus pushes the colon in front of it so that there is
dullness in the loin behind, while there is resonance below, which is not found
in pelvic tumours. On the right side the tumour and dullness are con-
tinuous with those of the liver, and there may be no small difficulty in
making a distinction ; the sharp edge of the liver and its greater movement
will be of help here.

To palpate the kidneys the surgeon stands on the patient's right and
places the palm of the left hand behind the loin and that of the right hand

on the abdomen ; this plan may be used for either kidney. The patient is instructed to open the mouth and take deep breaths, and the shape, size, mobility of the kidney can be ascertained. Where the kidney is of normal size but " movable " the method is slightly modified : at the height of inspiration, or rather at the very beginning of expiration, the observer brings his hands briskly together and catches the kidney, which is brought

down by the movement of in-spiration. This " catching " of the kidney requires a little practice but is important in demonstrating slight degrees of mobility.

EXPLORATION OF THE KIDNEY. Various routes of exposing the kidney for operative measures have been devised ; of these the abdominal, lumbar and dorsi-lumbar will be described.

(1) *The Abdominal Route.* The kidney can be reached through the linea semilunaris or rectus sheath, pushing the muscle in or out : this plan is never required except possibly in the case of enormous tumours in small infants, and even here it is questionable if the loin-incision carried forwards to the rectus-sheath or through this will not give as good or better exposure. The advantages claimed are that there is more room (which is doubtful), that the other kidney

FIG. 174. *c*, Oblique incision for exposing the kidney. *d*, Mayo's incision for exposing the kidney.

may be examined ; but palpation tells us nothing of the function of the organ.

(2) *The Lumbar or Loin Route.* The patient lies on the opposite side with the thighs and knees flexed, the uppermost arm on a support, and a sand-bag or prop under the lower flank to open out the space between the lower ribs and the iliac crest. The incision of four to five inches starts in the angle between the erector spinæ and the last rib, and passes forwards and downwards towards the anterior-superior spine. The latissimus and external oblique are cut through ; next the lumbar aponeurosis is split along the course of its fibres and the internal oblique and transversalis divided in the same direction. The perinephric, fatty capsule is thus reached, and is split by blunt dissection and removed where its super-abundance is troublesome, thus exposing the kidney. The assistant may

assist by pushing the organ up from in front. The kidney is shelled out of its fatty capsule and the ureter and hilum investigated. By enlarging the incision forwards the ureter may be explored to the pelvic brim, and through the enlarged incision a very large tumour may be removed.

(3) The dorsilumbar route of Mayo is perhaps the best of all, giving ready access to the hilum of the kidney and being capable of great enlargement if need be. The selected position is with the patient on the face, the spine being bent forwards with pillows under the abdomen ; we have found, however, that this method can be used very conveniently with the patient on the opposite side as usual. A vertical three-inch incision starts a good inch above the vertebral attachment of the last rib and opens the sheath of the erector spinæ an inch from its outer limit. The erector spinæ is retracted inwards and the middle and anterior lamellæ of the lumbar fascia and quadratus divided in the same line. At its lower extremity the incision is carried forward for two or three inches, slanting obliquely downwards and dividing the obliques and transversalis as in the lumbar incision. The perinephric fat is thus exposed and the kidney explored as before ; where more room is wanted the external arcuate ligament (which keeps the last rib tethered down) may be divided and the rib then retracted up, giving a very large amount of space, while the anterior oblique limb of the incision can be carried forwards as before. This should be sufficient to remove a renal tumour, however large, while it has the advantage, like the loin-incision, of being extraperitoneal, which is important, as most operations on the larger-sized kidneys are for infective conditions. This incision further allows the kidney to be exposed and sutured to the parietes higher up than the ordinary loin-incision.

When exposed the following operations may be performed on the kidney :

(1) *Pyelotomy*, or opening the pelvis to extract stones and explore the calyces. The pelvis should be sutured afterwards, and leakage for more than a few days is uncommon.

(2) *Nephrotomy.* The kidney is opened along the bloodless line of Hyrtl, which extends half an inch behind the convexity of the outer border. The pelvis can be explored and stones removed or drainage with a tube arranged ; the kidney should be sutured with deep sutures of plain catgut, tied only just tight enough to secure apposition and hæmostasis.

(3) *Nephrectomy.* The kidney is exposed and freed, the vessels are tied after transfixing the pedicle with interlocking ligatures, and the kidney cut away from its vascular attachments, leaving plenty of margin beyond the ligature to ensure against slipping of the latter. The ureter is at first left undivided and traced as far down as possible : where it is essential to remove as much ureter as possible, as in tuberculosis of the organ, a second incision may be made further inwards (of gridiron form) as for exploring the ureter, the peritoneum stripped from the iliac fossa, and the ureter freed down into the pelvis, even up to the bladder-wall, and there tied off and removed. We have found that in this manner the ureter can be very completely removed.

CONGENITAL DEFECTS OF THE KIDNEY AND URETER

(1) Absence or atrophy of one kidney is rare but important when the question of nephrectomy arises, since the solitary kidney is hypertrophied and if painful may be taken for a growth of the organ, with disastrous results. In such cases the presence of one ureter, as seen with the cystoscope, will prevent this error. In rare instances the ureter of the solitary kidney is double, and one ureter may open on each side of the
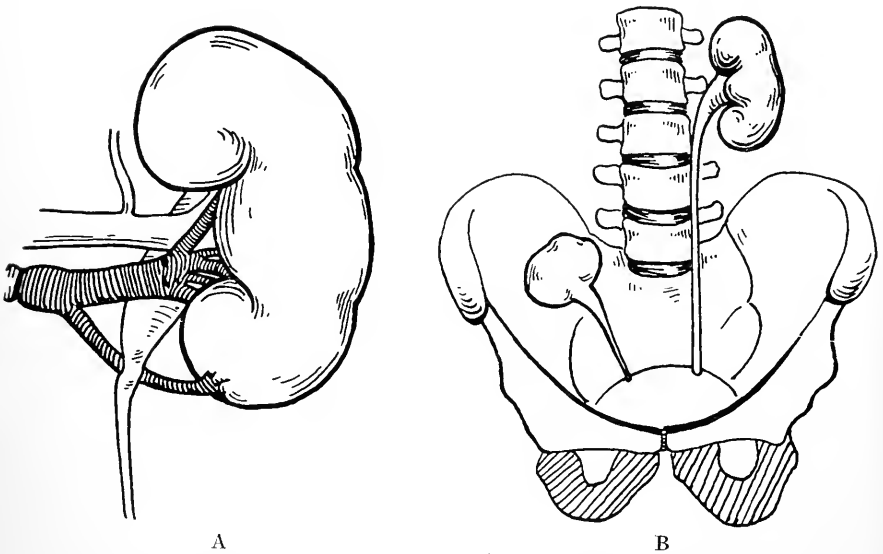
Fig. 175. Abnormal renal artery running to lower pole of the kidney behind the ureter, compressing the latter and causing hydronephrosis. B, Ectopic discoid kidney (Rt.) in the iliac fossa.

bladder (Kidd). In such cases pyelography or radiography after passage of opaque bougies will give the necessary information.

(2) Fusion of the kidneys, whether of the horse-shoe or discoid type, is of little moment except that, being usually out of place, the mass may be taken for a new growth. We have known the discoid kidney in the iliac fossa taken for an intussusception after rectal examination on two occasions in infants suffering with hæmorrhagic colitis (Fig. 175, B).

(3) The ureter in early fœtal life contains valvular folds, is rotated around the Wolffian duct or vas, at its lower end, while at its upper end the kidney undergoes some axial rotation. In this manner arise valves and kinks of the ureter, accounting for some instances of hydronephrosis. Finally, an abnormal renal artery may pass to the lower pole of the organ behind the ureter, which is an important cause of obstruction of the ureter and hydronephrosis (Fig. 175, A).

(4) The ureter and pelvis of the kidney are not infrequently double; this is not likely to be of consequence except in the rare condition of solitary kidney already mentioned.

INJURIES OF THE KIDNEY AND URETER

These may be subcutaneous or open, *i.e.* associated with an external wound.

(1) SUBCUTANEOUS RUPTURE. This is the more common condition and is caused by crushing violence, such as being caught between moving vehicles, buffer and run-over accidents, &c., but in some instances the organ is badly torn by apparently slight violence.

Pathology. The amount of damage incurred varies from small sub-capsular hæmorrhages to complete pulping of the viscus. If the hilum is the part principally affected the vessels may be badly torn and gross bleeding result, or the vessels may be weakened, leading later to traumatic aneurysm of the renal artery. The ureter may be torn across, leading to extravasation of urine and blood into the perinephric tissue. In addition the peritoneum may be torn, and consequently blood escapes more rapidly ; there is more likelihood of severe bleeding where the injury is intra- than where it is extraperitoneal : intraperitoneal rupture is more common in children.

Severe laceration of the kidney leads to suppression of secretion in that organ, and hence the extravasation is chiefly blood. In addition there may be some reflex inhibition of secretion in the other kidney, so that where the damaged organ is excised less than half the normal amount is excreted (possibly as little as five ounces *per diem*). This diminution very soon passes off, the amount of urine becoming normal in a few days, though the anatomical hypertrophy of the organ may continue for some months.

The dangers from rupture of the kidney are :

(*a*) Hæmorrhage, which is the most important and may demand immediate operation.

(*b*) Extravasation of urine, which, though harmless in itself (if the urine be normal), yet will lead in time to suppurative perinephritis and possibly peritonitis if the extravasation be not evacuated, as stagnant urine is a first-class medium for the growth of many pathogenic organisms.

Signs. Shock is marked in most instances where the laceration is severe, but may be trifling where the rupture is slight. Many cases present the picture of internal hæmorrhage, viz. great and increasing pallor, thirst, faintness, loss of vision and hearing, restlessness, a small rapid, feeble pulse (120 and upwards), and sighing respiration.

Locally there will be severe pain, often radiating from the loin to the groin and testis, and sometimes coming on in paroxysms of colic, from passage of clots down the ureter. There may be signs of local injury, bruising, &c.

Bleeding. Hæmaturia is usual, varying in amount from a mere trace to nearly pure blood. The blood may clot in the ureter, causing colic, less often in the bladder, where it rarely causes " clot-retention." Hæmaturia will be absent or minimal where the ureter is torn across or blocked with clot. As a practical rule, in all cases of abdominal injury the urine, if not passed by the patient, must be drawn off with catheter for examination.

Besides hæmaturia, blood may also be found in the loin as an elastic swelling, dull on percussion and passing round to the back, with rigidity of the muscles over it ; or there may be dullness in the loin which shifts on rolling the patient over, pointing to intraperitoneal bleeding and the necessity for immediate operation. When in doubt as to which side the blood comes from, the cystoscope may be of service if the bladder can be washed out sufficiently (where the bladder cannot be washed free of blood the latter probably comes from the bladder). Meteorism or flatulent abdominal distension is often found in these cases, either from associated lesion of the sympathetic plexus or irritation of this by retroperitoneal exudate.

Finally, it must be remembered that injury of the kidney may be complicated by injury to liver, gut, spleen, bladder, fractures of the spine or pelvis, and is not infrequently found while exploring the abdomen for internal hæmorrhage or rupture of the intestine.

Later signs are tenderness and an increasing swelling in the loin, with fever, showing that the extravasation is suppurating, *i.e.* is becoming a perinephric abscess.

Treatment. As regards treatment, these cases may be divided into :

(*a*) Those with hæmaturia only.

(*b*) Those with a swelling in the loin.

(*c*) Those with free fluid (mostly blood) in the peritoneum.

(*d*) Rupture of the ureter (*see below* (p. 514).

Hæmaturia may be present or absent in (*b*) (*c*) (*d*).

(*a*) In this class the damage is often slight, and patients frequently recover under expectant measures. The patient is kept warm in bed ; morphia gr. $\frac{1}{4}$ to $\frac{1}{2}$ is given to counteract shock and check bleeding, and careful watch kept for any signs indicating the need of operative interference. In many cases hæmaturia will cease in from two days to a week, but the patient should be kept in bed for ten days after bleeding has ceased.

Signs calling for operative interference in these cases are :

(1) Severity of bleeding as estimated by the patient's condition rather than the amount of blood in the urine. A rising pulse-rate, over 120, pallor, faintness, and sighing respiration usually mean that the bleeding is intraperitoneal and masked for some reason, *e.g.* obesity or tympanites.

(2) Persistent attacks of colic from the passage of clots.

(3) Hæmaturia lasting more than a week with no signs of diminution.

(*b*) Cases with swelling in the loin may be treated expectantly where the swelling is quite small. Where, however, the swelling is large or daily increasing (probably from rupture of the ureter), or where signs of suppuration occur, the loin must be opened.

(*c*) Where there is intraperitoneal bleeding operation should be performed at once.

(*d*) For rupture of the ureter *see below*, p. 514.

Operation. The kidney is exposed in the loin, for choice by Mayo's incision. When the diagnosis is made by laparotomy for intraperitoneal bleeding the abdominal wound should be closed before opening the loin.

The kidney is well exposed and its pedicle grasped to prevent further bleeding and the extravasated blood sponged away. Where the organ is pulped, badly torn, or the vessels are much injured, it should be removed. If the tearing is moderate an attempt should be made to save the organ if the patient's condition permit, the rent being sutured with stout, plain catgut passed deeply. The peritoneum should be sutured, if torn and injuries of the ureter treated as described below. In most instances where exploration is necessary the kidney will need removal. The loin is drained for four days.

When operation is done for suppuration drainage alone can be done at first. Should a urinary fistula persist later, it will require treatment (*see* Renal Fistula, p. 546). Clots in the bladder may cause retention, and an attempt should be made to remove them with the evacuator after breaking them up with a lithotrite ; failing this the bladder must be opened above the pubis.

(2) INJURIES OF THE KIDNEYS WITH OPEN WOUNDS. These mostly occur in military surgery from bullet, shell, or stab wounds.

Signs. Hæmaturia is usual ; later urine may escape from the wound and a urinary fistula develop.

Treatment. Wounds from modern military rifles are best treated by placing an antiseptic dressing over the wound and moving the patient as little as possible, giving morphia in $\frac{1}{4}$-grain doses to minimize shock. Indications from operation will then be as in the subcutaneous varieties. Where the wound is lacerated, as from bullets of low velocity, shells, &c., the wound should be explored by the usual incision and the organ treated as in cases of subcutaneous injuries, the parenchyma and pelvis being sutured if possible or the organ removed.

INJURIES OF THE URETER. Rupture of the ureter is due to similar accidents to those causing rupture of the kidney, but division may occur in surgical or gynæcological operations, usually in the pelvis.

Signs. Hæmaturia is slight, and there is some swelling in the loin. The usual course after such an injury is that a swelling appears and slowly grows in the loin at an interval of some days or weeks after injury. Ligature of the ureter at operation leads to primary hydronephrosis and later to destruction of the kidney by pressure-atrophy, while infection and suppuration often follow ; recovery of the kidney is possible for some time if the lumen of the ureter be restored (Frank and Baldorf).

Treatment. Cases following subcutaneous injury should be explored when the swelling in the loin does not diminish or increases under expectant treatment. The ureter is exposed (by the loin-incision) and if possible sutured.

The simplest method of suture is the " lateral implantation " of van Hook as follows : The lower end is occluded by a ligature and a slit made in this end below the ligature. The upper end, which is pared obliquely, is pulled into the slit by a suture, which is passed down the lower portion through the slit and tied on the outer surface of the lower end. (Fig. 176.)

In cases where inflammation and suppuration have occurred drainage

alone will be feasible at first, and if the rupture be only partial it may heal without further treatment. Where, however, the rupture is complete a urinary fistula will almost certainly persist, which will require further exploration and, if possible, secondary suture of the ureter, though in most instances of this nature it will be necessary to excise the kidney. When the ureter is cut or torn during operation it may be sutured in the manner described. Where the ureter is divided high up or low down it may be transplanted into the pelvis of the kidney or bladder respectively. The ureter, even though inflamed, may unite well if anastomosed in this manner. Thus in a case where the ureter gave way at its junction with the renal pelvis, from the pressure of an impacted stone, we anastomosed it into the pelvis of the kidney with complete success.

Later complications of ruptured kidney, apart from suppuration in the extravasated fluid and perinephric abscess, are :

(*a*) Of the renal artery : (1) secondary hæmorrhage (when infection occurs), necessitating nephrectomy ; (2) aneurysm of the renal artery.

(*b*) Of the ureter ; strictures and kinks leading to hydronephrosis.

(*c*) Of the kidney ; stones forming in clots in the pelvis.

ANEURYSM OF THE RENAL ARTERY. This is a rare affection appearing months or years after a
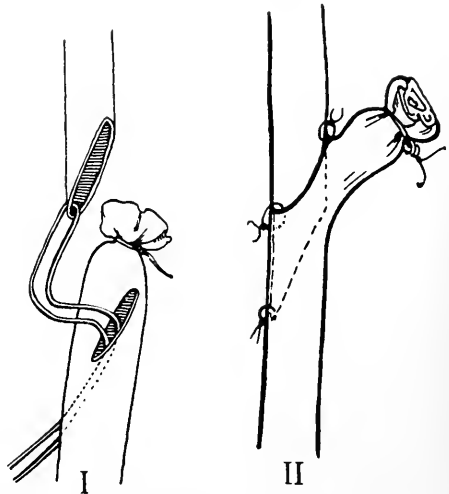
FIG. 176.   v. Hook's method of joining a divided ureter.

severe injury to the renal hilum, and is found clinically as a pulsating swelling of some size in the kidney region, associated in some instances with hæmaturia and indistinguishable from new growth till exploration is performed, when, if the nature is not obvious, incision will show laminated clot and reveal the nature of the tumour.

Treatment. Nephrectomy, with removal of the aneurysm.

To sum up, operation is indicated for rupture of the kidney where bleeding is severe and in most instances where there is a swelling in the loin, because the damage can be far more easily repaired before secondary, inflammatory and fibrosing changes have taken place, particularly when the ureter or pelvis is affected.

MOVABLE KIDNEY. NEPHROPTOSIS

Normally the kidney is kept in position by the intra-abdominal pressure, *i.e.* the tension of the obliques and transversalis muscles, depending but little on its fascial and peritoneal relations. When from various causes the intra-abdominal pressure is diminished the weight of the organ falls on

these last-mentioned supports, which stretch, and the kidney sinks and becomes propto ed or movable.

Various terms are used to express the degree of mobility :

(a) When a large part of the organ can be " caught " on deep inspiration as described in a preceding section (p. 509), the organ is said to be " palpable " ; where the lower pole only is felt the kidney should not be classed as movable.

(b) If, when the above manœuvre is performed, the hands can meet above the upper pole of the kidney, it may be described as " movable."

(c) While if the organ can be pushed about over a large part of the abdomen it may be called " floating."

In practically all cases the mobile kidney moves in its fascial and peritoneal sheath. In a few cases of " floating " kidney it is stated that the organ possesses a mesentery like the small gut—in fact a mesonephros ; such cases are very rare.

In the process of development the permanent kidney ascends to its final position from the pelvic region and may fail to ascend completely, just as a testis may fail to descend completely. Such a kidney is " ectopic," and may be associated with abnormal renal vessels, lobulation, double ureter, valves, kinks and strictures of the ureter, and fusion of the kidneys, whether of the discoid or horse-shoe type.

Ætiologically, then, such ectopic kidneys are to be distinguished from the proptosed form, but the results on the kidney may be identical.

Movable kidney is found very commonly in women (18 per cent. out of 2800 women examined, according to Mackenzie). Only about 1 per cent. of men are affected. The right kidney is far more often mobile than the left, though both are affected together fairly often. In 80 per cent. of the cases the condition produces no symptoms.

Causation. As has been mentioned, the main underlying cause seems to be loss of tone of the muscular tunic of the abdomen, which may be due to removal of an abdominal tumour or pregnancy, the muscles remaining pendulous and relaxed. Wasting, with loss of perirenal fat, dropping of the whole abdominal contents, or " enteroptosis " (Glennard's disease), may complicate the condition, while a loaded cæcum and constipation have been made responsible, and the conditions are certainly associated. Wearing of corsets, not necessarily " tight," undoubtedly plays a large part in deforming the lower thorax and upper abdomen, and in displacing the liver, stomach, kidney, and colon. The whole question of enteroptosis is complicated and is further discussed under Intestinal Statis, &c. (p. 263). Severe tight-lacing and sudden injuries account for some cases. Persons with flat, narrow chests, a small subcostal angle, poorly developed abdominal muscles, and a general flabbiness of nervous and muscular tone are particularly prone to mobility of the kidney.

Morbid Anatomy. These fall under two headings : (a) those which are a part of the cause of the mobility, such as kinks and twists of the ureter, lobulation, abnormal vessels, and found in the ectopic form ; (b) those which are the result of the mobility (and other defects, such as abnormal

vessels), viz. twisting of the renal pedicle, causing interference with the blood-supply, and draining off of the urine by the ureter. Interference with these leads to increase in the interacinous, fibrous tissue (*i.e.* a slight interstitial nephritis) and to dilatation of the pelvis (hydronephrosis), and later the infective changes of pyelitis, pyonephrosis, which occur more readily in a kidney whose resistance is lowered by impaired blood-supply and diminished outflow of urine. These infections are usually with the colon bacillus or pyogenic cocci, less often with the tubercle bacillus ; moreover, in these kidneys stones may form. As mentioned, symptoms are only present in 20 per cent. of the cases affected with the condition, and it is therefore likely that the pathological changes are absent in the bulk of the other 80 per cent. or of minor order.

Signs. The larger number of cases present no signs other than mobility ; signs, when present, are referred to the renal, alimentary, or nervous systems.

(1) RENAL SIGNS. The main symptom here is pain, which may be (*a*) of a dragging, constant nature associated with menstruation, worse when the patient is standing and entirely relieved by lying down (an important feature).

(*b*) Violent intermittent attacks (renal or Dietl's crises) accompanied by sweats, vomiting, the kidney being tender and the pain radiating to the groin and labium. Hæmaturia and albuminuria may be noted. The amount of urine passed in the twenty-four hours may be diminished, sinking to ten or fifteen ounces, and this is followed by increased secretion of stale urine of low specific gravity. This alteration in the urine is explained by twisting of the ureter in the pedicle of the kidney, producing an " intermittent hydronephrosis," but may also be due to interference with the blood- and nerve-supply of the organ from the same twisting. In other words, movable kidney is one cause of renal colic. As the condition advances, a definite hydronephrosis is found on palpating in the loin, the tumour being sometimes present, sometimes absent, and this change is associated with sudden voiding of large quantities of pale urine ; in this case there certainly is an " intermittent hydronephrosis."

(2) ALIMENTARY CANAL. In this group, copious vomiting of bile-stained material and sometimes jaundice may be found, and it should be noted that a mobile right kidney is often associated with disease of the gall-bladder, such as gall-stones or biliary catarrh, and it is possible that the drag of the kidney may cause partial obstruction of the biliary passages and account for catarrhal changes.

(3) NERVOUS PHENOMENA. In this class the patient has the usual symptoms of neurasthenia, is restless, irritable, depressed, has deficient will-power and flushings, and the pain is referred to the back, sacrum and coccyx, and is seldom absent or much relieved by lying down.

Diagnosis. The general diagnosis of a renal tumour has been already discussed. The conditions most likely to be confused with a mobile kidney are a distended gall-bladder, an enlarged deformed right lobe of the liver (generally due to corset-pressure and known as Riedel's lobe), and a pyloric

tumour. The former conditions are distinguished by being more mobile on respiration and more superficial, *i.e.* they are encountered right up against the abdominal wall, and are absolutely dull on percussion while the kidney has in front of it the resonance of the colon. A pyloric tumour is also more superficial and does not go back at all into the loin, while there are probably signs of dilatation of the stomach.

Care must be taken, before concluding that the mobile kidney is the fons et origo malorum, that there is not present in addition general splanchnoptosis or disease of the stomach or bile-passages. The functions of the last-named organs must be tested as described in the chapters on Abdominal Surgery, and in some cases it is not till laparotomy has been performed that one can rest assured that the kidney is the sole offender. Further, a movable kidney may be the seat of other disease, such as pyogenic or tuberculous infection, stone or growth (in some instances a result of the mobility), and the treatment will of necessity be different from that of uncomplicated cases of nephroptosis.

Treatment. In the first place, it must be clearly recognized that more than three-quarters of the patients with mobile kidney require no treatment, as the condition is producing no ill effects and no symptoms ; when discovered accidentally it is best to say nothing about the matter, or the patient may be constantly worrying about the defect.

Treatment in the Acute Condition (Dietl's Crises). The patient is placed in bed, the foot of which is raised ; hot fomentations are applied to the loin, and where the pain is very severe morphia is given : these measures soon relieve acute symptoms.

Non-operative Treatment. This consists in attempting to raise the intra-abdominal pressure by :

(1) Keeping the patient in bed four weeks and feeding on a fattening diet to restore the normal amount of perirenal fat, and at the same time

(2) Massage and exercises of the abdominal muscles should be practised to improve their tone. The patient lies on the back and raises the thighs, with the legs extended over the belly, several (ten to thirty) times, and continues this after leaving the recumbent position.

(3) The use of an abdominal belt to supply the place of the weak abdominal tunic. This should be discarded at night, as the kidney returns to its normal position when the patient is recumbent. An ordinary elastic abdominal belt, if fitting well and reaching from pubis to navel, is as good as any complicated " kidney truss."

Treatment on these lines should be employed in all cases where operative interference is not at once indicated, and should be persevered with for six months in cases with marked neurasthenia and general splanchnoptosis ; for in many instances when the general condition and the moral as well as the muscular tone are improved, the mobility of the organ, if not cured, will at least not cause further trouble.

OPERATIVE MEASURES. These are indicated where there is evidence that the kidney is being damaged by its mobility, such as hæmaturia, albu-

minuria, oncoming hydronephrosis, renal infection, or where the pain is very severe (Dietl's crises) or does not yield to the palliative measures already described.

In neurasthenic cases operation should be approached with great caution, but after a thorough trial of the palliative measures, if there be reason to believe that the mobile organ is the cause of and not merely associated with the neurasthenia, it may be undertaken.

Operation. The organ is exposed by the lumbar or, better, the dorsi-lumbar incision, the fatty capsule stripped, and the kidney and upper ureter carefully examined for kinks, twists, stenosis of the ureter, abnormal vessels crossing the latter to the lower pole of the kidney, or signs of infections, stone and hydronephrosis, which, if found, should be treated as described later.

Where no other defect but mobility is discovered the kidney is fixed to the parietes in a normal position, *i.e.* so that the vessels come off the aorta horizontally. To fix the organ, the proper capsule is split on its convexity and stripped front and back to within half an inch of the hilum. Two mattress-sutures of stout chromic catgut are inserted through the folded capsule on each side and through the quadratus posteriorly and the obliques and transversalis fascia and around the inner part of the lower rib externally. In this manner the parenchyma of the kidney is brought up against the parietal muscles and becomes firmly adherent ; the parenchyma is not in any way damaged but acquires an extra blood-supply from the muscles.

The patient lies on the back (the foot of the bed being raised for ten days), and is allowed up in three weeks.

RENAL CALCULUS

Of all secreting glands, the kidney is most prone to the formation of stones in its interior, and these play a very important part in the surgery of the kidney.

Ætiology. Stones may be divided into *primary* and *secondary*.

Secondary calculi arise from the invasion of the urinary tract by urea-splitting micro-organisms, which by converting the urea into ammonium carbonate render the urine alkaline and cause a precipitate of triple phosphates and calcium carbonate ; the crystals collect around any nucleus of clot, fibrin or foreign body, *e.g.* a bullet or Bilharzia ovum, and so a gradually increasing calculus is formed.

The formation of *primary* calculi is less well understood. There is probably a mild infection of the urinary tract, leading to the presence of particles of fibrin or some other colloid substance which forms the nucleus of the future calculus, and this is associated with a greater tendency for urates, oxalates, or phosphates to become precipitated. The reason for this greater tendency to precipitation is, however, not thoroughly clear.

(1) Uric acid is not infrequently precipitated in the urine before the latter is voided, and the crystals are known as " gravel." This may be due to excess of the uric acid or simply due to excessive acidity or deficiency

in pigment of the urine, rendering the uric acid less soluble. Large ingestion of meat and alcohol and deficient exercise are supposed to lead to the deposit of uric-acid gravel, which, however, may be passed for years without the formation of calculi.

(2) Calcium oxalate may also be passed in the crystalline form as " gravel " ; nor is such passage necessarily accompanied by formation of calculi.

(3) Apart from the triple phosphates of decomposition, calcium and magnesium phosphates may appear in the urine, before it is passed, as a white deposit, especially if the latter be neutral or alkaline, but this does not especially predispose to stone-formation.

To sum up : in the case of secondary stones the same infecting agent causes both a precipitation of salts and an inflammatory exudate to serve as a nucleus. As regards primary stones, the origin is probably a mild infection in a patient who has a proclivity for passing salts in his urine, in a condition readily precipitated. Stone is more common in hot climates such as India and Egypt, where sweating is excessive, pointing to the importance of a relatively deficient ingestion of water and concentrated urine as a causative factor. Excess of lime-salts in drinking-water (Norfolk) or in food is another well-recognized cause. Stones occur on both sides with sufficient frequency to make it essential to examine both sides before giving a prognosis in any case.

VARIETIES OF CALCULI. It will be gathered from the preceding sections that there are several varieties of calculi occurring with varying frequency. Rare formations are of *cystin* " green-stone," *xanthin* of reddish-brown colour, and *indigo* or " blue stone," of which no further mention is necessary. The commonly occurring stones are :

(1) In acid urine : uric acid, urate of sodium and ammonium, calcium oxalate, which are seldom pure but formed of concentric layers of the above-mentioned constituents.

(2) In neutral or alkaline (but not decomposed or ammoniacal) urine : calcium phosphate and carbonate, often mixed together.

(3) In alkaline ammoniacal urine which is decomposed by urea-splitting organisms, stones of the triple ammonio-magnesium phosphate and of calcium phosphate and carbonate occur. These last are secondary stones and formed as an ensheathing layer round a nucleus, usually of some stone of primary formation.

APPEARANCES OF CALCULI. (1) *Uratic Calculi.* In adults these are hard, smooth, and vary in colour from pale yellow to dark brown ; on section they show concentric laminæ of amorphous structure and consist chiefly of uric acid.

In children these stones consist chiefly of sodium and ammonium urates, and are more friable, smooth, and of buff or pale yellow colour.

It should be noted that pure uric acid casts no shadow on radiographic examination, but there is usually sufficient calcium oxalate in these stones to throw a faint shadow.

(2) Oxalate calculi occur in two main forms :

(*a*) The " mulberry," which is very hard, dense, spiculated on the surface, and dark in colour owing to an admixture of altered blood produced by its rough surface ; on section it is laminated and crystalline.

(*b*) A small rounded form of grey colour and smooth surface, seldom larger than a cherry-stone.

These stones afford very dense shadows in radiographs.

(3) *Phosphatic Calculi.* (*a*) Primary. These are smooth, greyish or yellowish white, and friable ; on section they are laminated and finely crystalline. These stones are usually small, grow slowly, and throw a good shadow with X-rays but less dense than that cast by oxalate stones.

(*b*) Secondary calculi of mixed phosphates (dirt-stones) are greyish or dull yellow, very friable, show no laminated structure, and are covered with crystals of triple phosphates ; they grow rapidly, and tend to be moulded in the form of the pelvis and calyces in which they lie.

Allied to these are *blood-stones* which consist of altered blood-clot, being of a brown colour, very soft and friable, in some instances consisting of little more than blood-clot, in others containing a variable amount of phosphates.

FIG. 177. Renal calculus (natural size). This branching (dendritic) type fits snugly into the calyces and pelvis of the kidney.

RESULTS OF RENAL CALCULI.

The presence of a calculus sets up local fibrosis in the renal tissue but seldom of great extent. Carcinoma sometimes develops in the renal pelvis from the prolonged irritation of a calculus.

Important results follow from the blocking of the urinary channels by calculi. When the obstruction in the pelvis or ureter is complete there is slight temporary dilatation of the kidney followed by atrophy, so that the organ is completely destroyed in a few months ; similarly, if one calyx is blocked the corresponding drainage area of the kidney becomes converted into a fibrous scar. Where the other kidney is out of action, complete blocking of the acting kidney causes calculous anuria (*see later*, p. 533).

If, however, the obstruction to the pelvis or calyx is incomplete (the more usual condition) or intermittent, the organ or part of it affected by the blocking becomes dilated and fibrosed. Thus an incomplete block of the renal pelvis or ureter causes dilatation of the pelvis and kidney, or hydro-

nephrosis, while a similar obstruction in a calyx causes a cyst to form on the part of the kidney involved. (Fig. 185, p. 536.)

Clinically partial obstruction of the pelvis or ureter is associated with " renal colic."

A renal calculus may pass into the ureter and remain impacted there, or passes down (causing colic) into the bladder, where it may remain to form the nucleus of a bladder-stone, or pass down the urethra and be voided with the urine or (especially in children, in whom the urethra is of less calibre than the ureter) may become impacted in the former.

A kidney which contains a calculus is of lowered vitality, and is therefore a more easy prey to the invasion of pathogenic bacteria, which as a rule arrive by the blood-stream. These organisms, particularly those of the colon group and staphylococci, set up suppurative inflammation of the kidney, viz. : (a) *pyelitis* where the renal pelvis is affected, (b) *pyelonephritis* where the pelvis and parenchyma are involved, while (c) where infection occurs in a kidney the pelvis of which is already dilated by hydronephrosis the result is a *pyonephrosis*. In some instances the infection spreads to the surface of the kidney and its surroundings, so that *perinephritis* results, which may suppurate (perinephric abscess) ; in rare cases this may point in the loin and burst, discharging the stone and leaving a fistula which discharges pus and urine (renal fistula). When the infection is of a milder variety the perinephric capsule becomes converted into dense fibrous tissue, till the organ is surrounded by a shell of cartilaginous hardness and atrophies under the pressure. Should the infective organism be able to decompose urea and render the urine ammoniacal, there will be a rapidly increasing deposit of triple phosphates on the stones already present.

When one kidney is greatly damaged by calculi the other undergoes compensatory hypertrophy.

Symptoms and Signs of Renal Calculus. The cardinal symptoms are pain and hæmaturia, both of which are not infrequently absent or slight and overlooked.

(1) *Renal pain* is of two varieties :

(a) That which is tolerably constant and of a dull aching or cutting character, referred to the loin and subcostal angle, sometimes passing to the front and even to the groin. This pain is not absolutely constant, for it tends to disappear or diminish when the patient lies down and is notably increased when the patient is jolted in any way, as by walking downstairs or riding in a cart over rough roads ; in such cases the stone is probably in the parenchyma of the organ, *i.e.* in one of the calyces, and has not yet reached the pelvis.

(b) Intermittent paroxysmal pain or " renal colic," which is of extreme severity and one of the most torturing from which humanity suffers. This pain comes on suddenly ; the patient is doubled up in agony, is nauseated, vomits, and drenched in cold sweat : in a few minutes the pain lessens, only to recur again shortly, rising and falling in severity for several hours or days, then passing off gradually, leaving an aching loin as a reminder. The

pain radiates widely to the back, groin, leg and testis, which may be retracted; it may spread to the neck of the bladder and perineum, and with this there may be intense desire to micturate every few minutes, but on attempting to do so only a few drops of blood-stained urine are voided : this last affection is known as "strangury." In other instances the attacks are of a similar nature but much less severe. In rare cases the colic is felt on the opposite side to that on which the stone is lying. The cause of this intense radiating pain is the cramp of the unstriped muscle of the renal pelvis and ureter, which are trying to force the stone along the latter to the bladder, and cessation of the pain means that (a) the stone has passed along the channel, or (b) has slipped back into the pelvis of the kidney, or (c) has become impacted and the ureteric muscle is tired out.

Strangury, or vesical tenesmus, usually implies that the stone is near the bladder at the lower end of the ureter.

(2) *Hæmaturia* comes on after the onset of the pain and is seldom severe, In many cases the urine is merely "smoky" and the bleeding escapes the notice of the patient; hæmaturia is likely to take place after jolts or jars, and in rare instances there may be profuse hæmaturia without pain.

(3) Increased *frequency* of micturition may be present where there is but little pain (a sign of renal irritation), and is most marked in the day-time when the patient is moving about, in contrast to the frequency of genito-urinary tuberculosis, when the frequency is most marked at night.

(4) *Strangury* only occurs with colic and is highly suggestive of stone.

(5) *Pus* is found in the urine when infection has occurred.

(6) *Calculous Anuria.* Failure to secrete urine due to the presence of stone is a rare condition, but a symptom of extreme importance and one demanding early surgical interference. This condition will be described in detail later, but its significance as a symptom of stone cannot be too strongly represented (p. 533).

Signs. Abdominal examination sometimes reveals nothing; but deep tenderness may often be elicited in the costo-vertebral angle, or in front over the ureter, by pressing rather sharply with a finger, when the patient feels as though a knife were being run into him. During colic the muscles are often too rigid to permit of palpation. The kidney, if palpable, may be tender or enlarged, in which case the presence of pyonephrosis is likely, rarely a hydronephrosis; in some instances the enlargement is a compensatory hypertrophy, the other kidney being extensively diseased.

Rectal and vaginal examination may reveal a stone in the lower ureter. The urine may be acid or alkaline and even ammoniacal, or may contain blood (often in microscopic traces only), crystals or pus, none of which are definite evidence of stone.

With the cystoscope the absence of vesical disease may be determined and the orifices of the ureters examined. A rounded, patulous or puffy orifice and the passage of pus or blood in the efflux or absence of the latter point clearly to the side affected, though not giving complete proof of the presence of stone as opposed to other renal disease. Finally, bougies may

be passed up the ureter and the point of obstruction noted ; of more service are the bougies impregnated with iron-oxide (Fenwick), which are opaque to X-rays and give useful information, confirming the location of the ureter and the shadows of doubtful stones contained therein.

X-rays.   By the employment of radiography the surgery of renal calculi

Fig. 178.   Renal calculi (oxalate).

has been improved enormously as regards accuracy of diagnosis, and X-rays are the most important method we have for investigating these cases, but care is needed to avoid the numerous pitfalls in this very special method of investigation.   It is essential to examine the whole urinary tract, *i.e.* both kidneys, ureters and bladder, for stones may be present on both sides with symptoms only referred to one, and a stone low down the ureter may give the same signs as one in the kidney.

The bowels should be well cleared out to avoid the shadows thrown by opaque substances in the intestine.   The patient lies on his back with

two plates, twelve by ten inches, under the lumbar and sacral regions respectively ; the respiratory movements of the abdomen are restrained by broad bandages attached to the couch or an air-cushion clamped down to the latter, and he is instructed to breathe with the thorax only. A " soft " tube is placed over the umbilicus and an exposure of two to three

FIG. 179. X-ray of loin showing elongate ureteric calculus just below the pelvis of the kidney and shadow of enlarged kidney (hydronephrosis) (this has been made too dark).

minutes is made. A good negative will show not only the transverse processes of the vertebræ but also the outline of the quadratus and kidney, and if the kidney outline is distinctly seen any stone present can hardly escape detection unless formed of pure uric acid, which is unusual. In doubtful cases a second radiograph, taken after three days, is of value, since shadows cast by intestinal contents will have altered their position.

Position of the Shadow. A useful landmark is a vertical line drawn through the mid-point of thei iliac crest. Shadows outside this line are seldom of

urinary origin but usually due to intestinal contents. Inside this line shadows may be renal, or of calcified glands and phleboliths. Discrete shadows along this line may be stones in the cortex ; if inside it, probably pelvic in position. The line of the ureter passes through the tips of the transverse processes of the lumbar vertebræ from the second downwards ; below this it crosses

Fig. 180. Fracture of the transverse process of a lumbar vertebra associated with pain referred to the kidney region.

the sacro-iliac synchondrosis and then gradually trends towards the middle line. Stones in the ureter will be in this line and of ovoid shape, with their long axis in the line of the ureter. If the kidney be displaced, an opaque bougie or collargol injection will give the direction of the ureter.

The shadows of calculi are well defined, rounded, or ovoid in shape, sometimes digitated, as when a large stone fills the pelvis and several calyces (Fig. 177), and several stones may often be present.

Sources of Error with Radiography. (1) Flaws in the plate are readily detected when the plate is examined with the light on it and not passing through it,

(2) Intestinal concretions and contents should be removed by a preliminary purge, and if there be any doubt a second examination will show a change of position.

(3) Phleboliths are especially common in the pelvic veins near the lower ureter ; they are very round with a clear, sharp edge.

(4) A calcareous deposit, whether in the kidney or a lymph-gland is characterized by its ill-defined edge.

URETERIC CALCULUS. The passage of stones down the ureter has been

FIG. 181.   Calculus in the pelvic ureter.   Note the faint oval shadow in the pelvis
on the reader's right, opposite the ischial spine.
(*Kindly lent by Dr. Gilbert Scott.*)

mentioned, and their detection and treatment form an important branch of renal surgery.

Stones which actually stick in the ureter are of ovoid shape, seldom larger than one-half by one-third of an inch, and formed of urates, oxalates, or calcium phosphates ; secondary phosphatic stones are uncommon.   The effect on the kidney of a stone blocking the ureter has been described, viz. that complete block leads to atrophy of the kidney, while partial block causes hydronephrosis and the consequent infection, pyonephrosis.   The effect on the ureter is that ulceration occurs at the site of impaction followed by stenosis, or the stone may perforate the ureter with abscess-formation, and possibly be discharged through the loin.   The ureter above the site of impaction becomes dilated and hypertrophied, so that it may be ten

times its normal size and thickness, and thus be easily mistaken at operation on account of its size, which in some instances is little less than that of intestine.

Signs. These are as in renal calculus, and it must be reiterated that diagnosis as regards localization of a stone rests on a complete radiographic
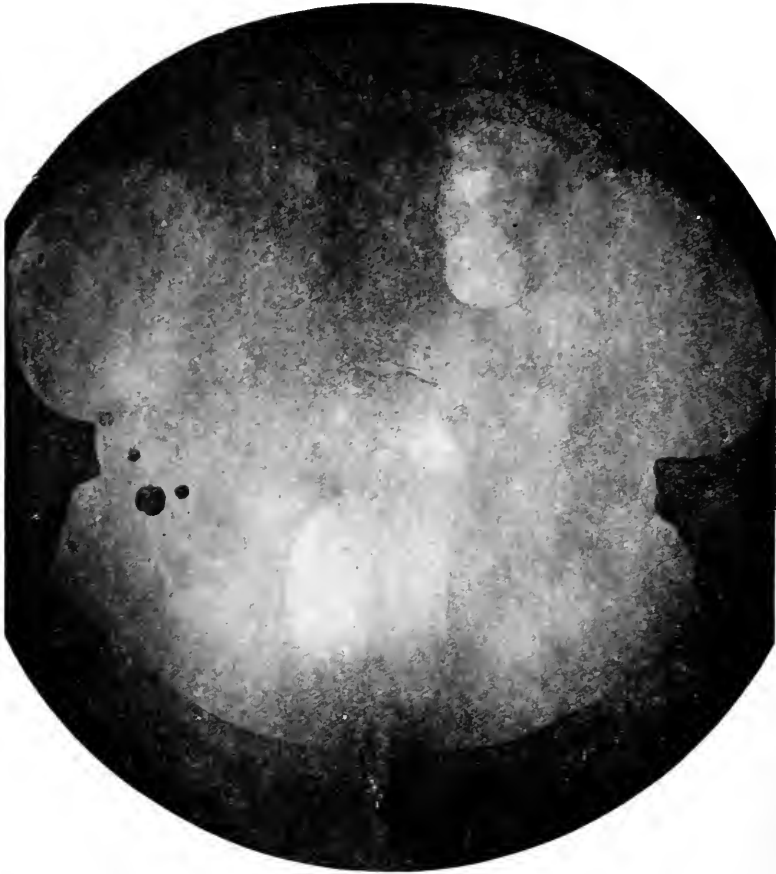
FIG. 182. Phleboliths in the pelvis, to be distinguished from ureteric calculi.

examination of the kidneys, ureters, and bladder. In rare instances the thickened and dilated ureter may be felt in the loin, and more frequently but quite occasionally a stone may be felt in the lower ureter, per rectum or per vaginam. The other signs—pain, colic, hæmaturia—are as with renal calculus. In fine, pain and colic at intervals, with an elongate shadow having its long axis in the course of the ureter, gives the diagnosis of ureteric calculus.

Diagnosis. Absolute diagnosis is seldom possible without a complete examination of the urinary tract, including that with X-rays. The patient may bring up stones which he has passed, showing himself to be a producer of stones, but this will not give the locality. The pain must be distinguished

from that caused by disease of other parts, such as lumbago, spinal caries, aneurysm, or other affections of the kidney, such as pyelitis, tubercle, growth, in which cases examination of the urine for organisms will be of service. The colic is to be distinguished from other forms of renal colic, *e.g.* the passage of blood-clots, fragments of growth, caseous matter, or blocking of the ureter by kinks, bands, twists (mobile kidney), aberrant vessels, &c.

Other acute conditions of the abdomen may resemble renal colic, including biliary and intestinal colic, intestinal obstruction, peritonitis (including such conditions as perforations or twists of viscera). The occurrence of hæmaturia, strangury, and retraction of the testis (when these occur) should make the necessary distinction. The paroxysmal, intermittent nature of renal colic differentiates it from acute obstruction of the intestine, in which the pain is continuous, while the persistent rigidity of peritonitis separates off this condition. In gall-stone colic the tenderness is in front at the ninth costal cartilage, and radiates to the right shoulder and not to the testis (*see* diagnosis of the Acute Abdomen, p. 113).

All cases of obscure pain referred to the back and abdomen and all cases of renal disease in which the diagnosis is not perfectly plain should be carefully investigated with radiographs and the cystoscope.

Prognosis. A renal calculus will ultimately prove the destruction of the organ in which it lies, though possibly not for some years, and as there is considerable prospect later on of the condition becoming bilateral, it is of the utmost importance to remove the source of danger and prevent its recurrence. The outlook varies with the sort of stone present. In cases of oxalate and primary phosphatic calculi the prognosis is good because the stones are usually unilateral, do not lead to infection of the kidney for some time, and seldom recur after removal. With uratic stones the prognosis is less good on account of the stones being often bilateral, multiple, and frequently recurring (probably owing to mild grades of infection). The prognosis with secondary phosphatic stones is poor, since the kidney is always much damaged by infection and the second kidney is usually affected as well.

TREATMENT OF RENAL CALCULUS. The stone should be removed as soon as it is diagnosed, to avoid further damage to the kidney, the only exception being when a number of small uric acid stones are passed, too small to throw shadows with X-rays. In such cases prophylactic treatment may be employed for some months, in hopes that all may come away, but even in such cases it is not good to wait too long.

Treatment is (1) preventive or palliative, (2) operative.

(1) To prevent the formation of stone in those who are the subjects of " gravel " and to check the recurrence of the disorder after removal of a calculus, the diet and mode of life must be regulated. In the first place, plenty of plain water, distilled for choice, should be taken to ensure flushing out of the urinary passages. Various mineral waters are also beneficial, differing according to the type of stone which the patient tends to form.

Thus in uratic cases alkaline waters such as Contrexeville, Vitel, lithia or potash waters, which raise the solubility of uric acid, should be taken; while for oxalate cases citrate of magnesia, sodium phosphate or Hunyadi water, which render oxalates soluble, are advised. The diet to diminish the amount of uric acid consists in avoiding foods containing nuclein, such as meat extracts, cellular organs such as sweetbread, while white meat, fish, bread, eggs, milk, and cheese are allowed. In oxalate cases, vegetables rich in these salts are to be avoided, as spinach, rhubarb; while dyspepsia often needs treating in these patients. For primary phosphatic cases the urine should be rendered acid by ordering acid sodium phosphate thirty grains three times a day, in half a pint of water. The function of the skin and bowels should be regulated, and moderate but regular exercise indulged in.

In secondary phosphatic cases the urinary tract should be made as clean as possible by the taking of urotropin, ten grains, with acid-sodium phosphate thrice daily, and attempts are made to raise the resistance of the patient to the infective organisms by inoculation with vaccine made from the organisms in the patient's urine.

Renal colic is alleviated by the use of hot baths, hot fomentations to the loin, the injection of morphia and administration of chloroform when the pain is very severe, while the morphia has time to act. It is seldom needful to operate for the severity of colic.

Operative Treatment. Operation is urgent in cases of calculous anuria (*see* p. 533), acute pyonephrosis, and blocking of one ureter; unnecessary in certain cases of minute uratic stones; in all other cases removal of the stone is necessary but not urgent.

Preliminary measures before operation are advisable in some instances where the renal function is poor; this includes rest in bed, the use of distilled water, urotropin, laxatives, &c., till the renal function has improved.

In most cases the operation to be practised is that of *nephrolithotomy.*

Operation. The kidney is exposed by the loin or dorsilumbar incision, stripped of its fatty capsule and explored, together with the upper part of the ureter. If a stone be found in the pelvis or upper ureter it is removed through a longitudinal incision parallel to the long axis of the ureter and the incision sutured with fine plain catgut and a drain-tube left down to this for three days. If no calculus be felt in the pelvis the kidney is palpated, and if felt elsewhere the kidney opened by a longitudinal incision through the bloodless portion, half an inch behind the greater convexity, and the stone removed. If the stone cannot be felt from outside, the kidney is opened along the same line sufficiently to admit the finger and the pelvis and calyces explored digitally and with a sound; the stone, when found, is removed, enlarging the incision if necessary. Bleeding is readily controlled while exploring by grasping the hilum with the other hand. After the stone or stones have been removed the incision is sutured with strong plain catgut, taking a wide grip and tying tight enough to cause hæmostasis but not to tear the parenchyma of the organ, which is friable. Before closing

the wound in the kidney or pelvis a bougie should be passed down the ureter into the bladder to make certain that no stone has escaped notice in the ureter. A drain-tube may be left down to the kidney for three days in case of urine leaking, but if there is pus in the pelvis of the kidney this should be drained for four days with a tube passing inside the pelvis. In doubtful cases the kidney should be drained.

Nephrotomy, or drainage of the kidney, is required in cases of secondary phosphatic stone, where infection is present, or for small pyonephroses. The operation is similar to the last described, but a larger tube is inserted after the stones are removed and is kept in longer, the resulting fistula being irrigated. In many cases the fistula closes but fairly often persists, and a secondary nephrectomy becomes necessary if the function of the other kidney be sufficient.

Nephrectomy, or ablation of the kidney, may be necessary, as just mentioned, after failure of a drainage operation, but may also be undertaken as a primary operation, the kidney in question being obviously useless, as may be suspected if on cystoscopic examination the ureter is patulous and has no proper efflux but only a drooling of thick pus, and when at operation the organ is found to be a mere sac of pus or bag of stones or a fibrous mass. Tolerably severe inflammation is no indication for nephrectomy; it is often surprising what ill-conditioned kidneys heal up in a few days after drainage and removal of calculi. The operation is similar to simple exploration of the organ up to the point where it is stripped from its fatty capsule. The latter may, however, be largely converted into dense fibrous tissue, and it may be very difficult to enucleate the kidney from its surroundings, the vena cava being endangered on the right side or the peritoneum being torn. In these difficult cases it may be well to strip the kidney out of its proper capsule. When freed to the hilum the vessels are tied with strong catgut after transfixing the pedicle and the ureter stripped, tied, and divided as far down the pelvis as possible. The wound is drained for four days, and healing is usually by first intention unless much infective pus has been spilled in the wound.

TREATMENT OF STONE IN THE URETER. The places where stones become impacted in the ureter are (*a*) the upper end at its origin from the renal pelvis, (*b*) at the brim of the pelvis, and (*c*) the lower end of the ureter near the bladder.

If the stone be quite small and in the pelvic ureter, particularly where stones have been passed before, a trial may be made of expectant treatment, viz. plenty of distilled water by mouth, urotropin to keep the urine sweet, and full doses of belladonna. If the stone be not passed in a few weeks, or should calculous anuria or signs of infection arise, operative interference is urgently needed. The upper ureter can be reached by the loin-incision as for exploring the kidney, and by extending this incision downwards exposed to the pelvic brim. Where the stone is about the pelvic brim and there is no reason for exploring the kidney, the iliac fossa is opened by a muscle-splitting incision as for removing the appendix but larger, splitting the obliques and transversalis along their fibres and then stripping the

transversalis fascia and peritoneum inwards from the iliac fossa. In this way the common iliac artery will be exposed at its bifurcation and the ureter found, crossing at this point to pass down into the pelvis. It should be noted that the ureter is generally raised with the peritoneum in this dissection, and when dilated resembles a piece of intestine rather than a goose-quill, and thus may escape detection at first. The stone is felt and extracted through a longitudinal incision, or if the stone cannot be reached easily (being low in the pelvis) the ureter may be opened in the wound above the stone and the latter extracted from inside the ureter with scoop or forceps, which if the ureter be dilated will not be difficult. In such cases a stone can be worked up the ureter from very near the bladder-wall. The wound in the ureter is closed with fine catgut and the muscles closed in layers, leaving a small drainage-tube down to the ureter for three days; leakage is usually trifling.

Fig. 183. View of the trigone of bladder showing a ureteric calculus ulcerating through the lower end of the right ureter close to the outer side of the ureteric orifice, surrounded by œdema and " bullous cystitis."

For stones in the last two inches of the ureter, which perhaps cannot be reached by the last route, there are other methods of approach :

(1) Where the stone is actually in the intramural part of the ureter, i.e. in the wall of the bladder (in which case it may be seen with the cystoscope bulging the bladder-wall close to the ureteric orifice or poking its brown nose through the latter), a suprapubic cystotomy should be done and the stone removed after dilating or slitting up the ureteric orifice.

(2) In women the lower two inches of the ureter may be reached per vaginam, after feeling the stone, by incising the lateral fornix and hooking down the ureter, which may be made more easily palpable by the insertion of a ureteric bougie.

(3) The ureter can be also reached from behind by the " parasacral " route, dividing the lower fibres of the gluteus maximus and great sacro-sciatic ligament, but the only landmarks are the spine of the ischium and a sound in the bladder, so that the method is not advisable in stout persons.

The wound in the ureter, even if not sutured, seldom leads to urinary fistula.

Finally, the ureter should not be opened through the peritoneum owing to the risk of infection should leakage occur. Stones unattainable by the loin or iliac routes may, however, be pushed up through an intraperitoneal incision and then extracted by a second incision in the iliac fossa.

CALCULOUS ANURIA. This highly important and urgent form of suppression of urine occurs in the course of calculus for various reasons.

It usually happens where one kidney is functionless or nearly so, whether from absence or disease, *e.g.* stone, inflammation, dilatation, growth. The ureter of the remaining kidney is suddenly blocked by a descending stone or in consequence of irritation from a stone or from inflammation, and ceases to secrete urine, *i.e.* the patient has been subsisting on one kidney for some time and the other is suddenly thrown out of action.

Symptoms. The affection is found usually in middle-aged or elderly men of gouty habit and with previous history of renal colic and hæmaturia, though occasionally no such history is forthcoming. The onset is commonly sudden, perhaps after some violent movement or sudden effort, with pain in one loin or renal colic, after which no urine is passed ; strangury is common ; in other cases the onset is insidious, painless anuria being the only sign. The characteristic feature of this condition is that no general effect is produced for some days, the patient feeling quite well or at most feeling slight nausea, weakness, or sleeplessness. This is known as the "tolerant period" and lasts about a week. After this time the second or "uræmic period" follows if the stone be not dislodged or removed by operation, though few signs of uræmia are present. A subnormal temperature, drowsiness, occasional twitchings, constipation, ending shortly in death from cardiac failure or œdema of the lung, close the scene. Headaches, convulsions, and coma are rare terminations, while œdema of the legs or trunk is practically unknown. The condition thus presents a very different aspect from the uræmia of nephritis, in which the last-mentioned symptoms form so prominent a feature, as well as the passage of small quantities of albuminous and bloody urine of high specific gravity before the anuria occurs.

Diagnosis. (*a*) From reflex anuria due to operation on the pelvis instrumentation, the history of which will render obvious.

(*b*) As the termination of double pyelonephritis in such cases the onset is gradual, preceded by purulent urine and rigors.

(*c*) Pelvic tumours, especially a cancer of the uterus, which as it spreads causes blocking of the ureters, producing first hydronephrosis and later anuria : vaginal examination will show the nature of the case. In cases of calculous anuria the affected kidney may be tender and enlarged ; a stone in the ureter may be felt per rectum or per vaginam. On examining with the cystoscope the ureter on the affected side will appear congested and patulous from ureteric-block, while on the obsolete side it may be golf-holed and drawn out of position, or absent. Radiographs will show the position of the stone. In rare cases both ureters may be blocked at the same time by simultaneously descending calculi.

Treatment. The indication is to promote free egress to the urine from the kidney with the least shock to the patient. Operation should always be undertaken, since removal of the stone reduces the mortality from 80 to 30 per cent., and to be successful should be performed as soon as possible

after the commencement of anuria. The side to attack is that where there has last been colic and pain, *i.e.* the side last affected. Where the position of the stone is made clear by radiographs the calculus should be removed as described above; but in emergencies, when uncertain of the position of the stone, the kidney should be exposed in the loin, the pelvis opened and drained, any stones being removed which can be readily found, but a complete clearing of the urinary tract is left to a future occasion when the patient's condition is less precarious. In doubtful instances both kidneys should be exposed and their pelves drained. If in such a case a stone is removed from the lower ureter bougies must be passed up and down to the kidney and bladder, in order to make quite sure that the whole ureter is pervious.

DILATATION OF THE KIDNEY AND PELVIS, NEPHRECTASIS HYDRONEPHROSIS, AND PYONEPHROSIS

Partial obstruction to the flow of urine from the kidney leads to dilatation of the pelvis and calyces, together with pressure-atrophy of the parenchyma ending in the conversion of the organ into a bag of fluid known as a nephrectasis or hydronephrosis. The fluid in this sac, consequent on the degeneration of the kidney substance from pressure atrophy, becomes less and less of the nature of urine and is finally little more than water containing a little urea and salts. Should the process proceed aseptically, *i.e.* without infection by pathogenic organisms, the contents of the sac clear, and it is called a hydronephrosis; but when infection intervenes, pus is formed by the interior of the sac wall, the contents are a turbid mixture of pus with the fluid of the cyst, and the swelling is called a pyonephrosis.

HYDRONEPHROSIS. There are many causes of obstruction to the flow of urine from the kidney, acting at different periods of life and in different parts of the urinary tract. The positions of the obstruction may be ureteric, vesical or penile, and may be congenital or acquired. Most cases of unilateral hydronephrosis are congenital in origin.

A. *Congenital Causes.* (1) *Penile*; pinhole prepuce, pinhole meatus, valves, strictures or total occlusion of the urethra (all leading, of course, to bilateral hydronephrosis).

(2) *Ureteric*; strictures, valves, kinks and twists of the ureter, and abnormal renal arteries crossing the ureter and obstructing it (these cases are unilateral).

In the first, or bilateral, group the hydronephrosis is often gross, the kidney destroyed and functionless, and the infant stillborn.

B. *Acquired Causes.* Strictures of the urethra, enlargement of the prostate, and pelvic tumours (notably cancer of the uterus), cause bilateral hydronephrosis. Causes of unilateral hydronephrosis are foreign bodies impacted in the ureter, such as stones, clots, parasites; stenosis of the ureter following ulceration; pressure on the outside of the ureter by tumours, pelvic cellulitis, &c. The ureter is narrowed by the manner of its develop-

ment at its junction with the kidney and bladder, and an excess of this natural narrowing easily leads to stenosis. Moreover, in the development of this tube, spiral folds and twists are present which should be smoothed out, but should they persist. lead to stenosis. The rotation, which the kidney undergoes as it passes up to the loin, accounts for some kinks of the ureter, while the occasional abnormal renal artery which grows out from the
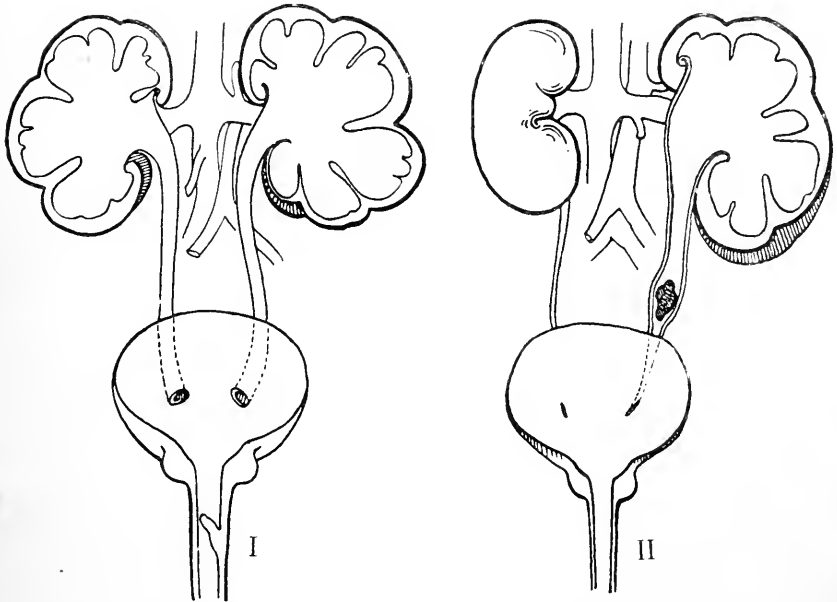
FIG. 184. I, Bilateral hydronephrosis, from a congenital valve of the urethra. (Author's case.) II, Unilateral hydronephrosis, from impaction of a stone in the ureter.

aorta and passes behind the ureter will strain across the latter, particularly when the kidney is mobile, and cause obstruction (Fig. 175 A, p. 511).

Pathology. The pelvis and ureter above the obstruction dilate, later, the kidney tissues become thinned, and a cyst results, filled with a fluid of low specific gravity containing traces of urea, some salts, and often albumen. The inside of the cyst is smooth, unlike that of a pyonephrosis, which is lined with granulation tissue. The cyst, as it dilates, pushes other organs aside, but does not become adherent, and microscopically the parenchyma is atrophic and replaced by fibrous tissue.

When both kidneys are affected the patient gradually succumbs to uræmia ; when the condition is unilateral the opposite kidney hypertrophies to compensate the loss, but the degenerated kidney seems to exert a morbid influence on the sound organ, since the latter becomes gradually fibrotic, and the patient is ultimately likely to die of uræmia if the hydronephrosis be not removed.

Signs. Clinically hydronephrosis appears under different aspects :

(1) *Uræmia* may be the cardinal symptom ; (2) *renal pain, hæmaturia,*

with or without a renal tumour, is found in others ; while (3) an abdominal or renal *tumour* brings the patient for advice.

(1) The uræmic type is chiefly found in bilateral cases, such as occur in infants with congenital block of the urethra or in adults from blocking of the lower ureters by cancer of the uterus invading the broad ligaments, stricture of the urethra, enlarged prostate, &c. In these cases the renal tumour may not be very large, and is perhaps masked by the distension of the intestine, from uræmic atony. The urine, which is of low specific gravity with a trace of albumen, suggests a granular kidney, but examination of the pelvis, urethra, and bladder reveals urinary obstruction in the lower part of the tract.

(2) The form with renal pain is often due to congenital defects in the ureter, kinks, abnormal vessels, &c., and is associated with mobility of the
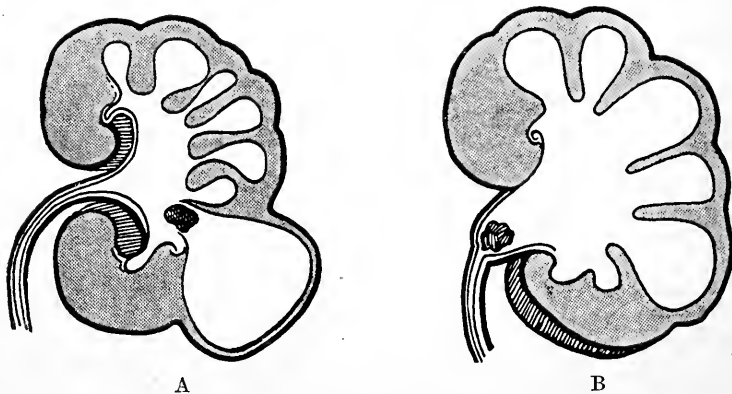
Fig. 185. Nephrectasis or dilatation of the kidney from impacted calculus. A, Local, causing a cyst of one calyx. B, General, causing hydronephrosis.

organ, stone, or stricture of the ureter. In this class are found the cases of " intermittent hydronephrosis " in which a renal tumour accompanied by pain appears at intervals, disappearing again with an outburst of polyuria. In this last group the kidney is mobile.

(3) Where an abdominal or renal tumour is the only sign, there is some slowly acting block of the ureter, and on more careful inquiry a history of renal pain, though perhaps slight, may be elicited.

The course is towards uræmia, in a few months in the bilateral cases, but not for many years in the unilateral form, and may be accompanied by infection of the degenerate kidney.

Diagnosis. From granular kidney, of which indeed hydronephrosis is a variety, investigation of the lower urinary tract, which reveals obstruction, will separate. Where a tumour is present the latter has the characters of a renal swelling, and may be felt to fluctuate or give a percussion thrill, if large (and some hydronephroses are enormous).

Small hydronephroses are to be distinguished from enlargements due to stone or tubercle, &c., by radiographs and bacteriological examination of

the urine. Larger forms are to be distinguished from pyonephrosis and polycystic disease. From the latter the smoothness and general fluctuation will help to distinguish, while from the former the absence of pyrexia and pus in the urine. It should be noted, however, that many cases of pyonephrosis are apyrexial at times, and if the ureter be blocked there is no pyuria. There is thus considerable chance of mistaking a pyonephrosis for a hydronephrosis, but the converse mistake is unlikely.

Treatment. This consists in removing the cause of obstruction, where possible. In bilateral cases circumcision, urethrotomy, removal of the prostate will be indicated according to the nature of the obstruction. Where the obstruction is in the ureter it will be needful to ascertain the site of blocking with ureteric bougies or radiographs (in the case of calculus) and explore the ureter in the loin or inguinal region ; in most instances it will be necessary to expose the kidney by the dorsilumbar incision, and trace the ureter to the site of obstruction. This affords opportunity of seeing the condition of the kidney, and where the latter is simply a fibrous sac it should be removed (nephrectomy), but if the kidney looks as if it might be of some use an attempt is made to relieve the obstruction, as by removing a stone or obviating a stricture. Strictures are excised, the upper end of the lower portion is then ligatured and the upper end pulled by a suture into an aperture in the side of the former (lateral implantation of van Hook), or still better, where the stricture is close to the pelvis, the end of the ureter may be sutured to the pelvis. These are more feasible plans than ureteroplasty, *i.e.* dividing the stricture longitudinally and suturing it transversely to increase the calibre of the ureter. A kink of the ureter due to mobility of the kidney may be corrected by fixing the latter in a suitable position, while abnormal vessels going to the lower pole should be divided. The value of the other kidney should be ascertained before commencing an operation for hydronephrosis in case nephrectomy seems indicated, since primary nephrectomy is more satisfactory than drainage, followed by removal of the organ.

PYONEPHROSIS. In this condition the kidney is not only hollowed out by pressure due to obstruction to the outflow, but is also suppurating inside from invasion by pyogenic organisms. In some instances the dilatation is primary, the condition being one of infected hydronephrosis. In other examples the infection is primary, the dilatation being secondary to some result of the infection, *e.g.* partial block of the ureter with debris of the disorganizing kidney, or from stenosis of the latter from descending inflammation (the last variety is generally due to tuberculous infection). Pyonephrosis will be more fully considered under infective diseases of the kidney.

INFLAMMATIONS AND INFECTIONS OF THE KIDNEY

In this section are considered affections of the kidney produced by infective organisms, merely mentioning those produced by (*a*) drugs such as turpentine or cantharides ; (*b*) toxines, *e.g.* scarlet fever ; (*c*) metals

such as lead ; and which result in the formation of those pathological formations large and small white, large and small red, beer drinker's kidney, &c., which are included clinically in the expansive title, Bright's Disease, and fully discussed in works of medicine.

Treatment. Though usually in medical hands there seem to be cases of acute nephritis in which anuria and uræmia supervene, where surgical measures may be reasonably employed. In such cases, if bleeding and transfusion, hot packs, &c., fail after fair trial, the kidney should be exposed in the loin and the capsule stripped (Edebohls) or nephrotomy performed, in order to relieve the congestion of the renal parenchyma.

PYOGENIC INFECTIONS OF THE KIDNEY. By far the most common organism in these cases is the colon bacillus, but staphyloccoci, steptoccocci, B. Typhosus, and the proteus of Hauser are often found. Bacteria may reach the kidney by (a) the blood stream ; (b) from the lower urinary tract, *via* the ureter or rather by its lymphatics ; (c) by spread from surroundings, as wounds or disease of the colon, lung, &c.

Modern authorities hold that the first or hæmatogenous route is the most common, and in many instances the infections are unilateral at their commencement. It is found that bacteria may circulate in the blood-stream and be excreted by the undamaged kidney without causing any changes that can be detected by clinical methods. The point of entry of the organisms may be some obvious focus such as a furuncle, tonsillitis, typhoid ulcer, inflamed appendix, cystitis, &c., while in other instances no definite focus can be found, but there is some general condition likely to account for the affection, *e.g.* constipation, pregnancy, &c., in both of which the colon bacillus is often found in the urine. This state of passing bacteria in the urine without any obvious disease is known as " bacilluria." It is evident that mere passage of organisms through the kidney is insufficient to cause infection there, but it is necessary that the organ should be damaged in some way before the invaders can effect a lodgment. Such damage is caused by the presence of stone, growth or mechanical injuries, while back-pressure from obstruction to the outflow of urine is a fertile predisposing cause, and a slight degree of mobility of the kidney is probably the underlying cause of the condition in those infections, otherwise hard to explain, which are so frequently found in women. Pregnancy is another definitely predisposing cause, " pyelitis of pregnancy " of varying severity being a recognized type. It is usually held at present that ascending infection *via* the ureter is uncommon, as the stream of urine tends to wash the organisms down the ureter ; and that obstruction to the outflow from the bladder (stricture, enlarged prostate) and some incompetence such as ulceration of the valvular opening of the ureter into the bladder is necessary before such upward passage can be effected ; and that even when infection results in such cases it is often hæmatogenous in origin. On the other hand, Walker and others find, experimentally, that ascending infection takes place rapidly by the lymphatics of the ureter without any obstruction to the urinary outflow.

Another predisposing condition is :

Reflex Disturbance.   Catheter Fever.   It has been shown experimentally that interference with the deep urethra causes vasodilatation and engorgement of the kidneys ; this may render the organ more susceptible to organisms circulating in the blood.   Catheter fever (*see* p. 619) and rigors, followed sometimes by pyelitis or even gross inflammation and suppuration of the kidney, possibly ending fatally, may result from the passage of a catheter, and shows the advantage of anæsthetizing the urethra locally before passing instruments, and avoiding cold afterwards, to save engorgement of the kidney, while at the same time taking measures to clear up any source of blood infection before the passage of an instrument.

Pathological Anatomy.   Various degrees of inflammation are found at operation and post-mortem.   The organs may be hugely congested and engorged, several times the normal size, and secreting pus from the reddened surface of the pelvis.   In other examples the congestion is less, but areas of anæmic necrosis are noted on the cortex, representing infective infarcts which may break down and form multiple abscesses, or run together and form one large abscess, while on section streaks of pus are seen radiating from the pelvis along the tubules and vessels.   Lymph is exuded upon the surface of the kidney, which may break down and form a perinephric abscess, or organize and form adhesions between the kidney and its surroundings (an evidence of past inflammation so often found in calculous cases).   Similarly the exudate in the substance of the kidney may organize and contract, forming puckered scars in the organ.   In cases where the infection is ascending there will be signs of back-pressure, viz. dilatation of the ureter, dilatation of the pelvis and thinning of the cortex of the kidney, while œdema and streaks of pus will be found in the kidney substance, as well as small abscesses.

Course and Symptoms.   (1) *Bacilluria.*   This term is used somewhat loosely to include those cases mentioned above, in which bacilli are excreted through the kidney without causing any discoverable lesion, and also a group of cases occurring mostly in children which must be regarded as the mildest form of pyelitis and cystitis ; this condition is often referred to as " coli cystitis."   In these patients there is often frequency of micturition, and the urine is found to be turbid, but acid, and with an odour like stale fish or mice, and containing albumen as well as quantities of the colon bacillus.

Treatment.   This consists in correcting the constipation, which is a usual concomitant (possibly the cause), and giving diuretics and urotropin.

(2) *Definite Infection of the Kidney, Pyelitis, Pyelonephritis, &c.*   From a practical point of view one variety should at once be separated from the rest on account of its urgency and because operative measures are usually needed, viz. ACUTE UNILATERAL NEPHRITIS (fulminating infective nephritis).

This is mostly found in women and on the right side, being a sequel of corset-deformity and prolapse of the kidney with back-pressure and secondary infection.   The onset is sudden, with high fever, vomiting, rigors

and great pain on the right side. On examination the patient is extremely ill, the tongue dry, face anxious, pulse 120 to 140, and there is rigidity along the right flank suggesting appendicitis, but higher up, reaching the costal margins, sometimes the enlarged kidney may be palpable, especially under an anæsthetic. The urine is scanty and may contain albumen or a little pus and organisms, while cystoscopic examination, after injection of indigo-carmine, shows that the right ureteric orifice is puffy, and no efflux comes from it, while a good efflux is present on the left side.

Treatment. In such cases operation is urgently needed, the kidney is explored from the loin, and various conditions found. Where simply large, œdematous, and red, without any signs of suppuration, nephrotomy (stones, if present, of course, being removed) and a drainage for a few days will be enough, but where the kidney is purple, soft, so as to show signs of breaking up when handled, with multiple abscesses on the cortex and, on incision, streaks of pus in its substance, nephrectomy is advisable. The results of such operations are good, but if such a highly infective focus be left the patient's chances are poor, so that it is important to recognize that such conditions are unilateral and that in really severe cases nephrectomy is indicated.

PYELITIS AND PYELONEPHRITIS. The onset is also sudden with fever, shivering, possibly rigors, vomiting, thirst, loss of appetite, headache ; sweats and diarrhœa are common. Fits and coma are uncommon.

Locally there is renal or lumbar pain, which may be mild or severe, and radiating to the groin or leg. Pain at the neck of the bladder and end of the penis as well as frequency of micturition by day and night are usual, and render confusion with cystitis likely. Later there is a swinging pyrexia up to 103° or 104°, drenching sweats, dry furred tongue, while twitchings, convulsions and delirium, passing into coma in severe cases, usher in the final stage : œdema is extremely rare.

Signs. Locally the kidneys are tender, front and back, and may be felt enlarged, but more often are not palpable, while the tumour with pyonephrosis may be huge. Pelvic examination may reveal ureteric stone, or pelvic tumours such as pregnancy, cancer of the uterus, &c., and in males urethritis, epididymitis and prostatitis. The urine may contain bacteria forming a dense haze or only found on centrifugalization or taking cultures. The reaction is acid when the infection is due to the colon bacillus or strepto-cocci, but alkaline where the proteus or staphyloccocci are present. Pyuria is frequent and profuse hamaturia may occur.

Cystoscopy should only be employed after the acute condition has passed off (except in the very urgent form, when there is a question of possible nephrectomy). This will show inflammation about the orifice of one or both ureters, and possibly blood or pus coming from the reddened pouting lips of the ureter ; in this way evidence for and against unilateral infection is obtained. Ureteric catheters should not be passed unless to obtain evidence as to the advisability of nephrectomy.

Radiography will be needed to discover the presence of stones.

The results of renal infection vary greatly.

In the milder cases the general symptoms, headache, anorexia, pyrexia, and thirst, pass off in a few days, while the fever is but slight and the amount of pus in the urine small ; such minor attacks may be recurrent. In the more severe cases repeated rigors occur, the amount of pus in the urine is greater and the symptoms all more severe. The enlarged and tender kidneys may be palpable ; these signs suggest infection of the renal parenchyma, *i.e.* pyelonephritis rather than mere pyelitis. In other examples again, the condition is chronic and persists for years with little effect on the general condition of the patient, though abscesses are present in the cortex of the organ.

Diagnosis. This has to be made from (1) cystitis and (2) other diffuse inflammations of the kidney (Bright's disease). As regard cystitis it should be recognized that vesical tenesmus, frequency, and the presence of pus in acid urine, are common to both conditions ; fever, however, is not present with cystitis, unless very severe and with alkaline urine, while thirst, rigors, sweats are only found in pyelitis. The cystoscope and ureteric catheter will clear up the condition when obscure. In general a case of apparently simple cystitis which does not clear up on lavage is really one of pyelitis.

Acute Bright's disease is distinguished by the general œdema, abundance of albumen and casts in the urine and absence of bacteria.

Chronic pyelitis, in which the uræmic condition is approaching, somewhat resembles in signs granular kidney, and it is important to look for causes of back-pressure such as stricture or enlarged prostate in such cases.

As mentioned, the fulminating cases are mistaken at first for appendicitis, and a careful consideration of the general condition, palpation of the loin, and use of the cystoscope is needed to make the diagnosis. Finally, it is important to recognize that such cases are usually unilateral, and prompt operative measures may save the patient's life or greatly accelerate convalescence.

Prognosis. This is very fair in early cases where the source of back-pressure can be removed. In old-standing cases, where the kidney substance is much reduced in quantity, the outlook is bad, as it is in acute cases where the condition is bilateral. In the fulminating, unilateral form the prognosis is good if operation is speedily undertaken, whether drainage or nephrectomy be performed according to the severity of the case. We have recently had four cases of severe fulminating infective nephritis, all of which recovered rapidly after nephrectomy.

Treatment. Attention must be paid to the prevention as well as the cure of infective nephritis, since there is little doubt that unwise or careless treatment may bring on or hasten the advent of this condition in cases which come under the surgeon's care for various diseases of the urinary system.

Prophylaxis. General measures consist in promoting a good stream of fluid through the kidney by taking bland liquids, as hot water, barley water, lemonade, Vitel or Contrexeville water, weak tea (gin is the stimulant

for urinary cases), and avoiding constipation and local sources of infection, *e.g.* oral sepsis.

Locally the causes of back-pressure, such as stricture, enlargement of the prostate, ureteric obstruction, should be obviated early, and such sources of irritation as calculi removed.

Care is needed in the passage of instruments, particularly in old persons, and, for the first time, keeping the patient warm in bed some hours before
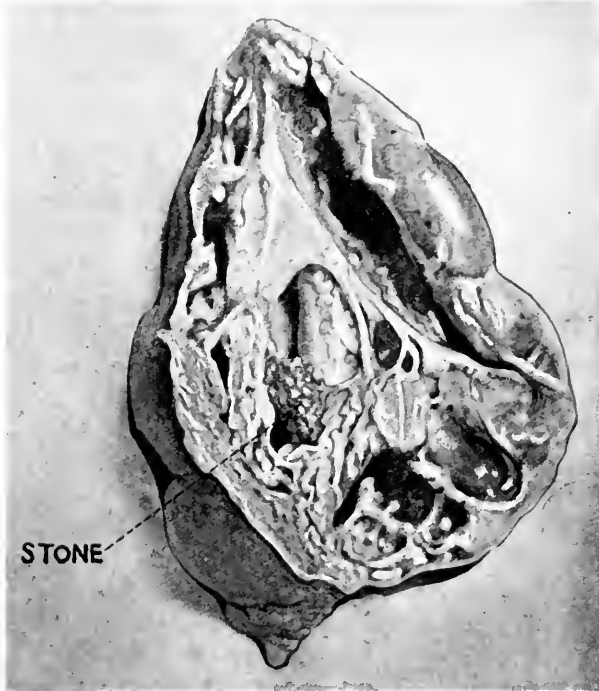
Fig. 186. Photograph of a calculous pyonephrosis laid open.

and after, anæsthetizing the urethra (novocain 2 per cent.) before passing the instrument, to avoid reflex disturbance ; not passing instruments needlessly or heedlessly in acute cases will do much to avoid this complication of many urinary disorders, which is always dangerous and often fatal.

When pyelitis is actually present the patient should be kept warm in bed, and free diuresis is promoted by the use of bland fluids, as above, to wash out the urinary passages ; the bowels should be kept open with pulv. jalapæ co. or similar laxative, while urotropin, five grains, should be administered thrice daily, with a drachm of potassium citrate and tincture of hyoscyamus (twenty minims) in a large amount of water, or with acid sodium phosphate (half a drachm) if the urine is alkaline. Vaccines from the patient's own urine are sometimes useful.

Should this course of treatment not avail against the infection, or where the condition is very acute, recourse is made to operative measures. The

drainage of the lower urinary tract is revised, and obstruction, such as
strictures, dealt with. The affected kidney is explored and drained, stones
or ureteric obstruction relieved, and finally nephrectomy may be required
in unilateral cases where the other kidney is healthy and the condition
does not yield to nephrotomy and drainage, or if it prove to be a useless
pyonephrosis, as well as in the condition of acute infection already described,
where the patient's life is in danger and the prospect of recovery from
simple drainage does not appear bright. Briefly, in the mild cases confine-
ment to bed and a course of diuretics, in the more severe cases drainage of
the kidney, will be the usual treatment.

PYONEPHROSIS. As mentioned in the last section, this condition may
follow a hydronephrosis, or the infection may be primary and the dilatation
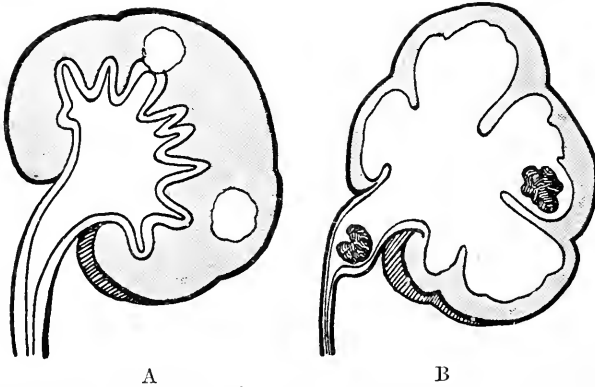
FIG. 187.   Diagram of difference between tuberculous and calculous pyonephrosis.
A, (tuberculous) Lining of pelvis and ureter thickened : caseous foci in cortex.
B, (calculous) Ureter small, pelvis dilated.

secondary. The infective agent may be the pyogenic cocci or the tubercle
bacillus; the latter will be discussed under Tuberculosis of the Kidney (p. 547).

Anatomy. When resulting from infection of a hydronephrosis, the
kidney is much distended, the cortex thinned to a mere shell of fibrous
tissue, with septa running in towards the hilum. This shell is lined with a
thin layer of granulation tissue and contains fluid varying from thin urinous
turbidity to thick pus. Where the infection is primary there is less dilata-
tion of the kidney, which is never enormous ; there is not the same thinning
of the cortex, some of which persists in wedges between the hollowed-out
abscess cavities. In either variety there will probably be secondary phos-
phatic stones, of soft consistency, lying in the decomposing fluid of the
interior.

Course and Symptoms. These may be as of hydronephrosis, viz. renal
pain, colic, and tumour formation, followed later by signs of infection,
fever, rigors, wasting and pyuria. In other instances the signs of infection
may be present from the onset, *i.e.* the condition is one of pyelonephritis,
and later a renal tumour becomes perceptible, while the pyuria is intermit-
tent, pointing to a variable block of the ureter. It will be noted that while

the pyuria is absent the fever, wasting, pain, and size of the tumour are increased owing to the damming up of the infective material in the interior of the organ. In other cases, again, the onset is insidious, a tumour in the loin being the first thing noticed, while wasting and pyrexia may be marked or scarcely noticeable. Pyuria is often absent, from the ureter being blocked with fibrous tissue early in the course of the affection. Tuberculous pyonephroses are often of this nature. The prognosis is good in unilateral cases after drainage or nephrectomy, but bad in the bilateral forms.

Diagnosis. This is to be made for other cystic tumours of the kidney, especially hydronephrosis, and the fever, wasting and thirst will generally suffice for this, but it should be noted that some cases of pyonephrosis are apyrexial for a great part of their course. The cystoscope will throw light in these cases, for the ureter will be dilated, patulous or golf-holed, and an efflux of pus may be found. Hypertrophy of a single remaining kidney (the other having become obsolete from past disease) with slight infection may be mistaken for pyonephrosis, but cystoscopy and examination of the efflux of each ureter will clear the ground and prevent an unnecessary and fatal nephrectomy.

In some cases perinephric and even intraperitoneal abscess in the loin (*e.g.* of appendicular origin) may resemble pyonephrosis. In these conditions, however, the swelling is fixed, not moving on respiration as does a pyonephrosis, and the swelling is more diffuse than a renal swelling. In the case of perinephric abscess there is more bulging in the back, and in neither case is there any change in the urine or ureteric orifice unless a perinephric abscess be secondary to renal suppuration.

Treatment. Where the condition is bilateral and the cause irremovable, *e.g.* advanced cancer of the uterus and broad ligaments, no treatment is available.

In other cases the dilated kidney should be opened and drained, while the causes of obstruction should be removed whether the condition is unilateral as from stone in the ureter, or bilateral as when following stricture.

Nephrectomy will be indicated either :

(1) Primarily, where the function of the diseased kidney is near zero, its prospect of regaining function minimal, and above all where the other kidney is known to be acting well.

(2) Secondarily, after drainage of the kidney, where the organ is useless, or where it is impossible to cause the urine to flow down the ureter, so that a urinary fistula remains which will not heal, always provided that the other kidney is of good function.

CIRCUMSCRIBED ABSCESS OF THE KIDNEY. Apart from pyonephrosis a circumscribed abscess is uncommon and may result (*a*) from suppuration round a stone blocking a calyx, (*b*) from the coalescence of several pyæmic abscesses, or (*c*) may be tuberculous in origin.

Signs. There will be severe pain in the loin with grave general disturbance, in the way of fever, rigors, &c. ; seldom will the swelling in the

loin be large enough to palpate. The diagnosis from acute infection or
early perinephric abscess can hardly be made before exploration is done,
when the abscess should be opened and drained and any stone be removed,
or if the organ be tuberculous nephrectomy be done ; hence the urine
should be examined for tubercle bacilli before commencing the operation,
and the efflux of the other ureter noted to see that the other kidney is
acting properly.

PERINEPHRITIS.   This is an inflammation in the loose perinephric
fatty and fascial capsule, and occurs in two forms (1) chronic or fibrosing ;
(2) acute suppurative ; the former being a milder variety than the latter,
but both are due to infection.

Causation.   The infection may be (*a*) blood-borne, often from some
undetected focus, and the effect on the pernephric tissues may be determined
by some injury causing extravasation there, of which rupture of the kidney
is an extreme example ; (*b*) it may spread from infection of the kidney
following on calculi, in which case it is usually of the chronic fibrosing type ;
(*c*) the infection may spread from neighbouring organs, such as the lung,
appendix, spine, gut, &c.

(1) The chronic fibrosing type is a common complication of infection of
the kidney, due to stone, pyelitis, pyonephrosis, tubercle, &c., and varies
from a slight deposit of fibrous tissue only noticeable at operation to a
dense, fibrous and fibro-lipomatous induration which renders enucleation of
the kidney a matter of extreme difficulty.   This condition is of itself hardly
to be diagnosed, and is entirely secondary in importance to the renal disease
to which it owes its origin, though in some instances renal pain seems to
depend on the presence of adhesions and is improved when they are
separated.

(2) Acute suppurative perinephritis is more often due to a blood-borne
infection or spread from neighbouring organs than to primary renal disease.

Signs.   The onset is sudden with high fever, rigors, sweats and signs of
irritation of the loin muscles and psoas, as evidenced by a bending of the
body to the affected side (acute scoliosis) and flexion of the hip, the muscles
in the infracostal space, erector spinæ and obliques being kept very rigid.
Later a swelling develops in the loin, in which, when large enough, fluctuation
can be detected, and which is distinguished from enlargement of the kidney
by not being ovoid in shape, by being not moving on respiration, by bulging
more backward, and later by redness and œdema of the skin.   Unless
secondary to infection of the kidney, which is unusual, the urine is normal
or at most contains albumen due to the febrile condition.

Diagnosis.   The rigidity of the lumbar muscles and the lateral curvature
of the spine distinguish from pyonephrosis ; an ordinary appendix abscess
is usually dull in front, and there is not the scoliosis noted with perinephric
abscess.

Other conditions in which the hip is flexed are :

(*a*) Tuberculous disease of the hip, but in this all movements of the
joint are affected, not only extension as in perinephric abscess.

(b) Sacro-iliac disease is distinguished by the tenderness felt on pressing the iliac crests together.

(c) In abscess secondary to spinal tubercle the swelling either does not project backwards (psoas abscess) or when it does (lumbar abscess) is not associated with lateral curvature, but only with angular kyphosis, while in neither condition is the suppuration acute.

Treatment. Incision and drainage should be performed as soon as the diagnosis is made, for this will often result in cure in a few days. When secondary to renal disorders these will require treatment such as drainage, removal of stones, eventually nephrectomy.

(3) Cold abscesses found in this region are usually due to tuberculosis of the spine and arise as painless swellings without rigidity of the muscles and without lateral curvature, but there is rigidity of the lower dorsal or lumbar vertebræ and localized tenderness on jarring the spine. The treatment of spinal abscesses is discussed under Diseases of the Spine (p. 445, vol. i).

Renal Fistula. In this condition there is a communication between the pelvis of the kidney or the ureter with the outside of the body or with the intestine or lung. A wound of the renal cortex is insufficient to cause this ; further, openings into the pelvis or ureter generally heal spontaneously unless there be some cause to prevent it, such as a block in the ureter below or chronic suppuration in the kidney, as after opening a pyonephrosis where the kidney is badly disorganized. Fistulæ may, therefore, follow wounds leading into the pelvis, whether surgical or accidental, and from suppuration in and about the kidney, when the abscess bursts on the surface or into the lung or gut. Such fistulæ consist of narrow suppurating tracks usually opening at the surface on the loin or groin and discharging pus of varying consistency according to the bacterial flora present, mixed urine more or less altered according to the condition of the kidney. Thus the discharge may vary from practically normal urine, as may happen when stones have been removed from the kidney, but one blocking the ureter has been overlooked, to pure pus when a pyonephrosis, with total disorganization of the kidney, has been opened.

Treatment. Fistulæ are prevented by early operations for stone and infective conditions of the kidney, and by taking care that the ureter is clear after all operations on the kidney. In treating fistulæ attempts should be made to estimate the function of the kidney to which the fistula leads, and if the discharge is of fairly normal urine attempts made to restore the channel of the ureter by removing calculi and stenosis, anastomosing the ureter, &c. Should these measures fail, after patient attempts, the kidney may be removed, but only if the other kidney is acting well. When the discharge is practically pure pus and the kidney certainly functionless it should be removed. This may be very difficult from the amount of perinephric induration present. In such cases ligature of the renal artery has been proposed as an alternative, as the discharge may thus be lessened by cutting off the blood-supply, and the operation is far easier since it may be performed through a laparotomy incision.

RENAL TUBERCULOSIS. Tuberculosis of the kidney is found :

(1) As part of general miliary tuberculosis, the kidney being studded with miliary tubercles ; this condition is merely an incident in a hopeless disease, and therefore demands no further notice.

(2) As an ascending infection from the bladder, prostate and epididymes.

(3) As a blood-borne infection which attacks the kidney first of the genito-urinary system, is rarely if ever the primary focus in the body, but secondary to some nearly obsolete focus in the lung, bronchial glands or elsewhere. This is a common form and is important because it is usually unilateral for a long time, does not tend to spontaneous cure, but to destruction of the organ, though the symptoms often intermit over a number of years, and it can be cured by nephrectomy.

Modern research tends to show that tuberculosis of the kidney is usually hæmatogenous in origin, fairly common in young adults, especially males, and is often unilateral and localized for a considerable time.

Anatomy. In the hæmatogenous form there may be no change on the surface of the kidney ; sometimes miliary tubercles are found and in other instances

FIG. 188. Tuberculous kidney (longitudinal section). Two calyces of the lower pole are badly involved and lined with chronic granulation tissue. Scattered tubercles are seen elsewhere in the renal parenchyma and in the ureter, which is thickened.

perinephric adhesions. Caseating nodules are found at the junction of the cortex and medulla, usually at the upper or lower pole, and these nodules break down and burst into the pelvis, leaving cavities lined with granulation tissue, and the infection spreads in the form of miliary tubercles to the mucosa of the pelvis and ureter. By the formation and bursting of these nodules the kidney is gradually destroyed and the infection spreads down the ureter, which may be blocked by the process leading to pyonephrosis, while phosphatic calculi form in the cavities left by the broken-down caseous masses. In other examples nodules form in the submucous tissue of the pelvis which break down and form ulcers, invading the pyramids ; clinically this last form may be characterized by profuse hæmaturia. In another type the ureter is chiefly affected, being blocked by granulation tissue causing a pyonephrosis to arise. The ureter becomes

thickened, infiltrated and fibrosed, and the ureteric orifice in the bladder becomes red, swollen, pouting, and is laterally displaced outwards by the contraction of the fibrous tissue in the ureter ; later there is ulceration of the ureteric orifice and of the surrounding bladder. In the less common ascending cases the changes are most marked in the bladder vesiculæ, prostate and epididymes, which are ulcerated and caseating ; miliary tubercles are found along the ureter with tuberculous ulceration of the pyramids of the lower pole.

Symptoms and Course. It takes from six months to three years, in some instances as much as ten years, for the organ to become completely disorganized. For a considerable part of this time the disease is localized, but ultimately will spread to the bladder and other kidney, the course being progressively destructive as far as the kidney is concerned.

Pain may be of the renal or bladder variety.

Renal pain is a dull aching in one loin not affected by rest or movement.

Bladder-pain occurs quite early, before the bladder is really affected, from the irritation of the tuberculous material passing into the bladder, and is noted at the end of micturition, at the tip of the penis, or in the perineum. These attacks of bladder-pain last several days and mark the bursting of a caseous node into the pelvis of the kidney ; when the focus has discharged itself the pain intermits, till another focus bursts.

Frequency of micturition is a most important symptom. When occurring night and day, especially in young men, it is fairly often an early symptom, and may be the earliest, being present before any pain or hæmaturia is noted.

Profuse *hæmaturia* is occasionally the initial symptom, lasting a few days and seldom recurring.

In the pyonephrotic type the presence of a tumour in the loin may be the first thing that draws the patient's attention to the condition.

Signs. A tuberculous kidney is seldom palpable except when in a condition of pyonephrosis. It may be tender, but it should be borne in mind that a healthy kidney may be hypertrophied and tender, the diseased organ being atrophic. A craggy epididymis, nodules in the vas, and in the prostate (per rectum) will point to a tuberculous origin of renal and bladder symptoms.

The Urine. It is on an investigation of the urine that the diagnosis chiefly turns. There is increased secretion of urine (polyuria) in the early stages, which in part accounts for the increased frequency of micturition. The specific gravity is lowered and the urine appears pale.

Pus is present in the urine, in quantities which vary from time to time, according as the caseous foci burst into the pelvis of the kidney. The pus settles down to the bottom of the urine in a specimen glass in a definite layer with a well-marked line of separation from the urine above (the pus in cases of cystitis is less well separated from the urine).

The reaction is acid ; the presence of " pus in acid urine " is, however, not pathognomonic of tuberculosis as was at one time held, since, as has been

already mentioned, it is found in cases of pyelitis where the organism responsible cannot ferment urea (*e.g.* the colon bacillus). Further the reaction in cases of tuberculosis may become alkaline where a secondary infection has taken place.

Blood is seldom found in the urine except in the early stages, when it is occasionally profuse. It is well then to remember that painless hæmaturia may be due to early tuberculosis of the kidney.

The tubercle bacillus must be found if diagnosis is to be certain, and is only of significance where pus is present as well, since recent investigations have shown that under certain conditions the non-tuberculous kidney may excrete tubercle bacilli which are circulating in the blood. It is not always an easy matter to demonstrate tubercle bacilli, when present. The urine must be drawn off with sterile catheter to avoid contamination with the smegma bacillus (which inhabits the glans prepuce and anterior urethra and is identical in shape and very nearly in staining reactions with the tubercle bacillus). The uriné will require centrifugalizing to agglomerate the bacilli before the sediment is placed on a slide and stained in the usual manner.

Cystoscopy will often reveal changes at the ureteric orifice, viz. dilatation, redness, pouting, displacement outward, efflux of pus and, perhaps, ulceration around.

The urine is collected from both kidneys with the ureteric catheter and examined for pus and tubercle bacilli, while the renal function is tested by a preliminary injection of indigo-carmine. This is important, for if both kidneys are affected with tuberculosis, or if the function of the sound kidney is below normal, nephrectomy will be contra-indicated.

General Signs. Wasting, hectic fever, night sweats and anæmia are only present when the condition is far advanced; there is no cardio-vascular hypertrophy.

Diagnosis. From calculus the affection is distinguished by the fact that in the former condition the pain ceases on resting, and slight hæmaturia is apt to be present all through the disease ; by the absence of pus in the urine in early cases of stone, and whereas in calculous cases the pyuria increases when once it has started, in tuberculosis it often remits at intervals. There is no well-defined shadow on radiographic examination of tuberculous kidney, though a calcified pyonephrosis will give a large diffuse shadow. Pyelitis of the more chronic varieties can only be distinguished on bacteriological examination of the urine. Acute pyelitis will always be due to infection with the colon bacillus or pyogenic cocci and never with the tubercle bacillus.

The diagnosis, therefore, depends on finding the tubercle bacillus in the urine and, when found, in settling from what part of the urinary tract it comes (whether from the bladder or from one or both kidneys), by the cystoscope and ureteric catheter.

Prognosis. The class of case with frequency, some bladder-pain, pus in acid urine, and the bladder clear or with but slight ulceration round the

ureter, is of importance, since in these cases the disease is well localized, and cure by nephrectomy well-nigh certain.

In cases where the kidney is enlarged and tender, and nodules are found in the epididymes, vesiculæ or prostate, the bladder is usually much involved and prognosis much less favourable, nephrectomy being seldom advisable.

In cases where there is a large pyonephrosis, the ureter being blocked as the condition is often well localized and the results of nephrectomy are good. The main consideration is early diagnosis, for much the best results are from primary and early nephrectomy.

Treatment. The only cure is by nephrectomy. It must not be assumed that because there is no pus in the urine for a while that the kidney is healed, since this may be due to blocking of the ureter, the kidney being gradually destroyed all the time. Nephrectomy is indicated where one kidney only is involved, even where there is slight affection of the bladder as well or of one of the testes (which should also be removed), or foci in other organs with tendency to heal. Removal of the organ is also indicated if it be converted into a bag of pus, even where the other kidney is slightly affected as well, for removal of a large focus of tubercle will prolong life even where the remaining kidney is affected and death from this cause ultimately certain. Where both kidneys are affected or where the patient's condition is on the down grade from other foci, nephrectomy is contra-indicated.

As regards operation, the kidney should not be opened before removal, *i.e.* the diagnosis should be certain before the operation is commenced, since opening the infected organ will very likely cause tuberculous infection of the wound : the lumbar route is, of course, taken to avoid the peritoneum. The ureter must be removed as close to the bladder wall as possible by a second " gridiron " incision in the iliac fossa, stripping the peritoneum from the latter as for exploring the ureter. It is best to avoid opening and draining the kidney if possible. This procedure may occasionally be employed to diminish the size of a very large pyonephrosis previous to its removal a few days later, or in cases where the urine of the two kidneys cannot be separated by the ureteric catheter drainage may be employed to form an idea of the function of the remaining kidney, prior to a proposed nephrectomy. Local and partial excision and curettings of the kidney for tubercle are best avoided.

RENAL SYPHILIS. As a rare condition in tertiary syphilis, interstitial fibrosis and gummata may arise. The more diffuse interstitial form resembles a sarcoma, the breaking down gumma suggests tubercle. Clinically a painless tumour of the organ is found with but slight changes in the urine ; hæmaturia occasionally occurs, but pus is never present. These cases are generally mistaken for new growths, and the diagnosis not made till after excision.

NEW GROWTHS OF THE KIDNEY. The predisposing causes are : (*a*) developmental errors such as failure in the proper junction of the collecting with the secreting tubules of the kidney, causing cystic dilata-

tion of the secreting portion (polycystoma) ; or inclusion of embryonic remnants (" rests " of surrounding organs, *e.g.* the suprarenal, myotomes of the abdominal wall, &c.).

(*b*) Irritation, especially from calculi of long standing, produces cancer of the pelvis, in rare instances.

New growths of the kidney appear at two periods of life, viz. during infancy and in middle life. The tumours may grow in the parenchyma, pelvis or perinephric tissues, and may be innocent or malignant. Innocent (*i.e.* non-invading) growths may destroy life if bilateral, from the amount of renal tissues destroyed (polycystoma).

By far the larger number of tumours of the kidney discovered clinically are malignant.

Varieties and Anatomy. (1) *Polycystoma or Congenital Cystic Kidney.* The kidney is filled with thin-walled cysts varying in size from pin's head to an orange, filled with fluid which may be clear, yellow, blood-stained, brown or colloid. The cysts are situated throughout the organ, projecting on the surface, and are lined with flat, cubical or columnar epithelium according to the size of the cyst : by their pressure they cause much fibrosis and atrophy of the parenchyma of the organ.

(2) *Renal Mesothelioma*, also known as " Hypernephroma " or " Grawitz Tumours." These tumours are of a yellowish-brown colour and are circumscribed, tending to push the renal parenchyma in front of them rather than to invade it, and usually possess a capsule. In structure they consist of large polygonal vacuolated cells containing glycogen, arranged in a network closely resembling in appearance the " zona fasciculata " of the suprarenal gland. They may be dormant and innocent for years, but are inclined to take on invading and malignant properties later. They have been regarded as " adrenal rests," but as the cell-content is glycogen and not fat, and as they occur in the cortex, not in the capsule, and often at the lower pole, while portions of them resemble renal tissue, they are now generally admitted to be of renal origin and are classed with the mesotheliomas. They seldom cause any symptoms or signs till they have assumed a malignant tendency, and then are to be considered as cancers or sarcoma, or a mixture of these.

(3) *Adenocarcinoma.* This consists of cubical or columnar cells arranged in the form of alveoli, the walls of which may be one or many cells deep ; the cells are also found growing out into the lymphatics. These tumours are greyish-white in colour with areas of degeneration and interstitial hæmorrhages, and at the edge merge gradually into the renal substance proper. They may be an advanced condition of the mesothelioma.

(4) Sarcomas of round or spindle cells sometimes containing giant cells are occasionally found growing from the capsule.

(5) *Sarcomas of Infants* (Wilms's Tumours). These are classed as teratoblastomas by Adami, and are supposed to originate from undifferentiated or pluripotent cells of the primitive myotome, *i.e.* cells which will later become spindle muscle, bone, cartilage, renal epithelium, &c. These growths consist of round, spindle, and giant cells in a myxomatous matrix ;

striated muscle-fibres, and gland cells may also be present, as well as
cartilage, bone and fat in the less malignant types, and the growth often is
of enormous size, filling a large part of the abdomen.

(6) In the pelvis of the kidney are occasionally found villous tumours
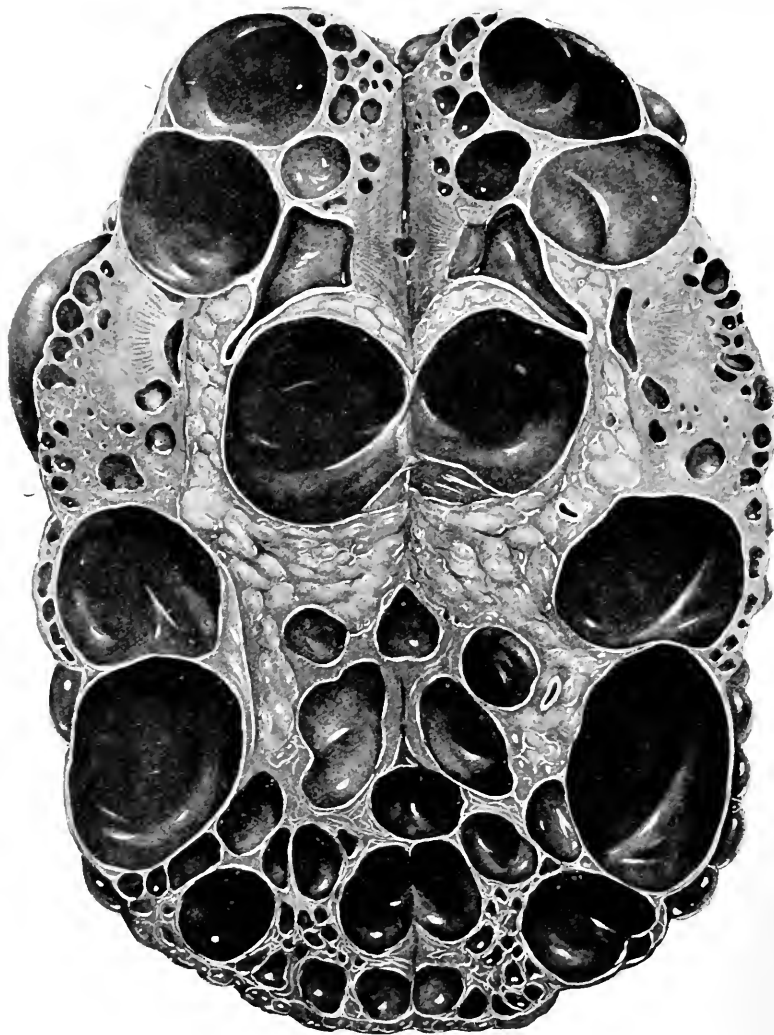
Fig. 189.   Congenital cystic disease of the kidney (bisected and laid open).   The
organ is made up of a collection of cysts of varying size surrounded by fatty and
fibrous tissue, very little sound kidney substance remaining.

resembling those more commonly occurring in the bladder, and consisting
of feathery projections covered with columnar epithelium.   The ureter is
readily blocked by such a growth, and the kidney may become hydro-
nephrotic.   These tumours are malignant, ulcerating and invading the
kidney substance.

Rare conditions starting in the pelvis are squamous-celled cancer (the result of irritation by calculi), and angeiomatous formations, which may cause severe hæmorrhages ; in some instances at least the latter are rather to be regarded as inflammatory conditions than new growths in the strict sense.

For practical purposes, renal tumours may be divided into innocent and malignant, and the only innocent tumour is the polycystoma if we except the small tumours which may be true adrenal " rests," or small meso-theliomas which remain small and innocent for a long time, and only come into clinical cognizance when they begin to grow rapidly and take on malignant properties.

(2) *Polycystoma* (Congenital Cystic Disease). The anatomy of this condition has been described and the organ is practically in a condition of advancing fibrosis and atrophy, the extent of the atrophy varying, and being complicated by the presence of cysts. The disease is slowly pro-gressive and usually bilateral, though one side is often more advanced than the other. Occurring in infants before birth it may prove, from its mere size, an obstacle to delivery, or it may be found in persons of advanced age dying from some intercurrent cause. In other instances the disease proves fatal from destruction of the renal secreting cells, the patient suffering with consecutive cardiovascular hypertrophy and dying of uræmia, with anuria, convulsions, &c., just as do patients suffering from " granular kidney." This is in many instances a family disease, and may be associated with malformations of other organs, such as cystic disease of the liver. The underlying cause is obscure ; some hold it to be an innocent neoplasm (cystadenoma), others that it is the result of a failure of the secretory tubules to join effectively with the collecting tubules of the kidney ; while others, again, consider that in adults, at any rate, the condition is simply a large number of retention cysts due to inflammatory fibrosis strangling the renal parenchyma.

Signs. Mention has been made of labour obstructed by such tumour of the fœtus. In children, bilateral renal tumours and gradual death from uræmia is the clinical picture. In adults there may be a long latent period, the tumour perhaps being found accidentally. Intermittent attacks of hæmaturia occur, usually painless, but sometimes with colic from the passage of clots down the ureter. Later the urine becomes of low specific gravity, containing albumen and casts, and general failure ending in uræmia closes the scene.

Diagnosis. This is often difficult and may entrap the very elect. A renal tumour and hæmaturia (usually painless) in middle-aged persons suggests a malignant growth. The fact that the urine resembles that found with granular kidney, that the tumour is usually bilateral, or that blood comes from both ureters (cystoscopic examination), and that the lobulated effect of the larger cysts may be palpable from the abdomen and even fluctuation obtained, will help to make the diagnosis. From bilateral hydronephrosis the smoothness of that tumour and the presence of some

obstruction in the lower urinary tract will be of assistance. Where uræmia has set in care is needed, thus we have known such a case sent up as a cerebral abscess on account of the fits. The diffuse non-focal nature of
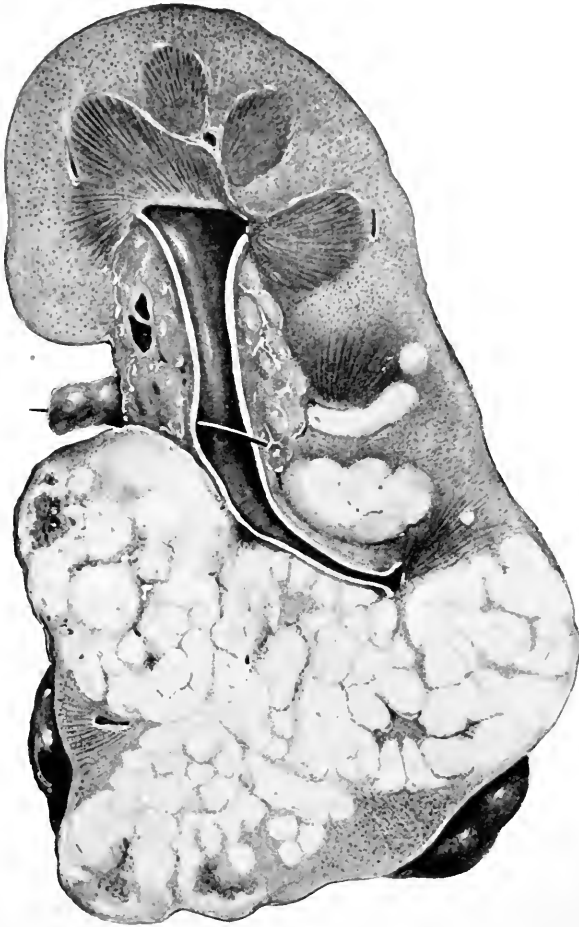
Fig. 190. Renal mesothelioma (Grawitz tumour or hypernephroma). The growth involving the lower pole of the kidney is of yellowish colour and is invading the remainder of the kidney.

the fits, the scanty albuminous urine, and the lobulated masses in the abdomen on either side made the diagnosis.

Treatment. The life of the patient must be regulated as in case of granular kidney, and operation is only for exploratory purposes, where there is some possibility of another condition being present.

MALIGNANT TUMOURS. With the exception of the last mentioned condition all tumours which can be recognized clinically may be regarded as malignant.

Most of these tumours are encapsuled at first, but sooner or later spread to (a) the renal parenchyma and pelvis, causing hæmaturia, (b) the aortic

lymph-glands (in the case of adenocarcinoma or malignant papilloma) and thence to the posterior mediastinum, (c) more commonly the tumour grows into the renal vein, and emboli split off, causing secondaries in the lungs, liver and bones.

Symptoms and Course, in Adults. The affection may be latent for years, being only discovered when the abdomen is palpated for some other reason or at post-mortem. Hæmaturia is the earliest symptom, and is profuse, lasting some days and then ceasing for no obvious reason ; it is mostly painless, but may be accompanied by " clot-colic," where the bleeding is free and clots in the ureter, the clots appearing in the urine like tapes or macaroni. These casts are also found with calculus but less often. Also with calculus pain precedes hæmorrhage, while in the case of growth bleeding always precedes the pain. There is no frequency of micturition with renal growths.

Signs. A tumour in the renal position is less often the earliest or only sign and may be felt, especially under anæsthesia, having the characters already described (p. 508). Small growths, particularly of the pelvis, cannot be felt from the abdomen. The sudden appearance of a varicocœle in middle-aged patients is suggestive of new growths, as it is not found with other enlargements of the kidney.

With the cystoscope, blood may be seen coming from one ureteric orifice and there may be dilated veins round the orifice. Examination of the urine will show absence of pus, tubercle bacilli, and other organisms ; while radiographs will show that no stone is present. Except for blood there will be no changes in the urine (casts, altered specific gravity), a point of distinction from granular kidney and polycystoma.

Painless hæmaturia, with or without a tumour in the loin, is an indication from cystoscopy at once, and where the blood comes from one kidney and there are no signs of stone, tubercle, or granular kidney, there is probably a malignant growth, and the kidney should be explored from the loin. If the tumour in the loin is fixed the condition is almost certainly inoperable, much more so if there is œdema of the leg, ascites, or jaundice.

Signs in Children and Infants. In these cases there is a painless renal tumour, often of vast size, with no changes in the urine. The diagnosis has to be made from hydronephrosis, which is fluctuating and often bilateral, and from polycystic disease, which is lobulated and bilateral.

Prognosis after operation in adults is fair in cases discovered early, at the first onset of hæmaturia, and is better in the case of the mesothelioma type than more definite cancers and sarcomas.

Painless hæmaturia is therefore a symptom of the utmost importance, and should never be treated expectantly in middle-aged persons, every effort (including exploration) being made to exclude new growths, since the only hope of safety where a growth is present lies with early nephrectomy.

Treatment. In cases where the kidney is not fixed and there are no secondary deposits and where the function of the other kidney is satisfactory (indigo-carmine test), nephrectomy should be performed. The kidney should

be removed with as much of the fatty and fascial capsule as possible, the lymphatic glands at the hilum and around the aorta being also removed and the ureter down to the bladder.

CYSTS OF THE KIDNEY. Besides hydronephrosis and polycystomas
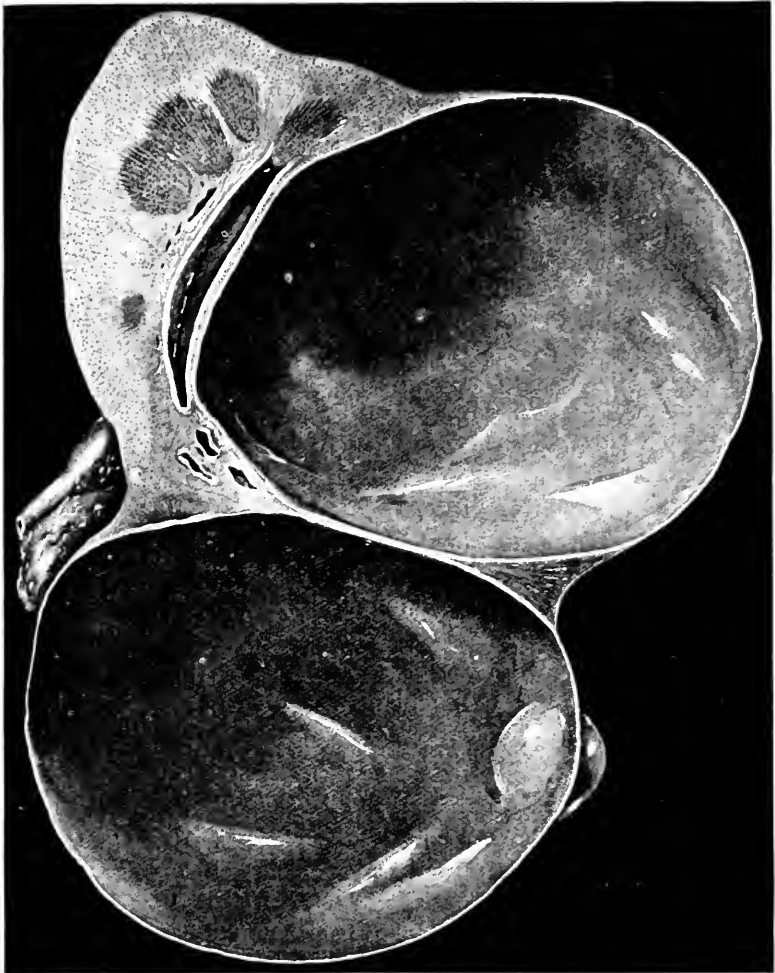
FIG. 191. Large solitary cyst of the kidney, bisected and laid open. The compressed kidney and its pelvis are clearly seen, presenting a different picture to that of a hydronephrosis.

there are a few other varieties of renal cysts which require notice. These are :

(1) Simple cysts ; (2) retention cysts ; (3) hydatids ; (4) dermoids ; (5) cystic degeneration of new growths.

(1) *Simple or Serous Cysts.* These grow out from the cortex and have a thin, fibrous wall firmly adherent to the kidney, lined with flat epithelium and containing clear or straw-coloured fluid. It is uncertain whether these

cysts originate from obstruction to renal tubules due to some error in development or are caused by lymphatic obstruction.

Clinically these cysts are found in middle-aged women in the position of renal tumours, but with no urinary symptoms; their nature is often only revealed at operation.

Treatment. When possible they should be removed by dissection; this often proves impossible, in which case either a partial nephrectomy should be done or the lining membrane destroyed with pure carbolic and the cavity packed and allowed to heal by granulation.

(2) Retention cysts are often multiple, of small size, on the surface, and filled with clear fluid; they are associated with granular kidney and are of no surgical importance.

(3) Hydatid cysts resemble those found elsewhere, and may burst into the pelvis and the fluid or daughter-cysts be discharged by the ureter and bladder, or the cyst may dry up and calcify or suppurate. Clinically they are found as cystic swellings in the renal position without urinary signs, unless on bursting into the pelvis there results colic from the passage of daughter-cysts down the ureter or hooklets are found in the urine.

Diagnosis. From other renal cysts this is usually difficult, but a pronounced eosinophilia of the blood is suggestive, while finding daughter-cysts or hooklets in the urine proves the nature of the swelling.

Treatment. The kidney is exposed as usual and the nature of the condition recognized by the thick white, chitinous coat of the parasite. The cyst is tapped and partly emptied, when the chitinous coat tends to separate from the adventitious, fibrous sheath and is removed entire by dissection. Where there is much bleeding the cavity is puckered by deep sutures (marsupialized) or packed with gauze and drained for a few days. Where the kidney is badly disorganized nephrectomy may be the sounder policy.

(4) Dermoid cysts are very rare and resemble those of other parts, and are removed by dissection.

(5) Cysts in new growths demand the same treatment as the growth to which they owe their origin.

CHAPTER XXXIV

SURGERY OF THE BLADDER, PROSTATE AND MALE URETHRA

The Bladder : Anatomy : Congenital Affections, Allantoic Cysts, Ectopia
Vesicæ : Injuries of the Bladder : Foreign Bodies : Vesical Calculus : Litho-
lapaxy : Lithotomy : Cystitis : Tuberculosis of the Bladder : Bilharzia : Ulcers :
Diverticula and Pouches : New Growths of the Bladder : Cystectomy : Fis-
tulæ of the Bladder : Incontinence of Urine : Retention of Urine : Atony of
the Bladder.
The Prostate : Anatomy : Injuries : Calculi : Prostatic Abscess : Chronic
Prostatitis : Tuberculosis of the Prostate : Adenoma and Enlargement of
the Prostate : Catheter-life and Prostatectomy : Cancer of the Prostate :
Sarcoma of the Prostate.
The Male Urethra : Anatomy : Congenital Defects, Pin-hole Meatus, Hypo-
spadias : Injuries : Foreign Bodies : Gonorrhœa and Urethritis, Complications :
Stricture : False Stricture : Organic Stricture : Instrumentation, Catheter
Fever : Methods of Treating Stricture : Complications, Peri-urethral Abscess,
Extravasation, Urethral Fistulæ, Cancer of the Urethra.

Anatomy. In adults the bladder is chiefly pelvic, while in infants it lies
mostly in the abdomen. The empty bladder in adults may be regarded
as a pyramid, the sides of which consist of four triangles, and the downward
pointing apex of which embraces the prostate and lies half an inch below
the subpubic angle. The lateral surfaces lie against the levatores ani and
sides of the pelvis in relation to the ureter, vas, vesical vessels, and the
obturator vessels and nerve. The posterior surface is in relation to the
vesiculæ seminales, vasa, and rectum, the relation to the latter below being
immediate, but above the mid-point of the vesiculæ the recto-vesical fold
of peritoneum intervenes. In the female the posterior surface lies against
the uterus and vagina without the intervention of any peritoneal reflection.
The superior surface is entirely covered by peritoneum, and in front ends
in a fibrous cord, the urachus, which is a relic of the continuation of the
bladder outside the body known as the "allantois." This urachus raises a
fold of peritoneum as far as the umbilicus. When the bladder fills the
distension is mostly at the expense of the upper surface, which expands
into the abdomen, the other surfaces being practically inextensile ; the
peritoneal reflection from the anterior abdominal wall is raised as the
bladder fills, so that there may be as much as two inches between the
lower margin of the peritoneal reflection and the upper margin of the
pubis. Inside the bladder the urethra opens at the apex, while the
ureters open as slits on the posterior surface or floor about an inch and a
half behind the internal meatus of the urethra and one inch apart. The
triangular space of which the ureters and urethra form the corners is the

" trigone " and is smooth, the mucosa being firmly adherent, whereas over the rest of the bladder the mucosa lies in folds when the bladder is empty, to allow of expansion.

Examination. This has been for the most part discussed under the General Diagnosis of Urinary Disease (p. 493). It may be pointed out that a distended bladder forms a rounded, fluctuating tumour rising out of the pelvis, immovable and dull on percussion and easily palpable per rectum ; while it may be emptied with a catheter if one can be introduced, unless the bladder be filled with clot or growth. Of special importance is it to note the manner of micturition and test the completeness of this by passing a catheter after to see if any residual urine be present, which will suggest atony or a diverticulum of the bladder. The cystoscope and radiograph will throw much light on the diagnosis of bladder conditions.

CONGENITAL AFFECTIONS OF THE BLADDER. The bladder is formed as part of the diverticulum from the hind-gut known as the allantois, being the remains of part of the intra-abdominal portion of the latter. Maldevelopment may occur : (*a*) in the place where it takes origin from the hind-gut, which forms the primitive cloaca and has been described under Malformations of the Rectum, viz. those varieties of imperforate rectum where the latter opens into the bladder or urethra (pp. 317–320).

(*b*) The process of shutting off the bladder from the rest of the allantoic sac may be improperly performed, the result being either (1) an umbilical, urinary or *urachal* fistula, (2) allantoic cysts, (3) ectopia vesicæ.

(1) Urachal fistula has already been described under Affections of the Umbilicus (p. 271).

(2) Allantoic or urachal cysts are the result of persistence of the allantoic stalk between the bladder and the umbilicus, the intra-abdominal part of the allantois being shut off from the bladder but remaining hollow and forming a cyst. The characters of these cysts resemble those of a full bladder, but they cannot be emptied by the catheter, while their occurrence in men will distinguish them from ovarian cysts, which otherwise they much resemble : malignant changes are prone to develop in the wall of such cysts, and their removal by dissection is indicated.

(3) *Ectopia Vesicæ.* In this condition the side walls of the abdomen have never fully enclosed the bladder, so that the front and sides of the latter are wanting, the base, including the ureters, being on a level with the front of the abdomen ; at birth the umbilical cord covers the front of the ectopia.

Signs. This affection is easily recognized as a red pulpy tumour, present after separation of the umbilical cord, in the mid-line of the hypogastrium, being about an inch in diameter. This rosy tumour is kept moist by the constant flow of urine from the ureters, which may be recognized as small slits on either side of the tumour ; they are brought to light more readily after drying the surface, when the small jets of urine will be noted. The constant dribbling of urine excoriates the neighbouring skin. The pubic symphysis is absent, the pubis ending considerably short of the middle line ; the penis is usually cleft, as is the scrotum, while the testes are

imperfectly descended. The constant dribbling incontinence and the eczema arising from this leads to a pitiable condition of the patient.

Treatment. The plan of forming a new front wall to the bladder by turning over flaps from the anterior abdominal wall (Wood) and perhaps loosening the pubis by dividing the sacro-iliac ligaments (Trendelenberg)
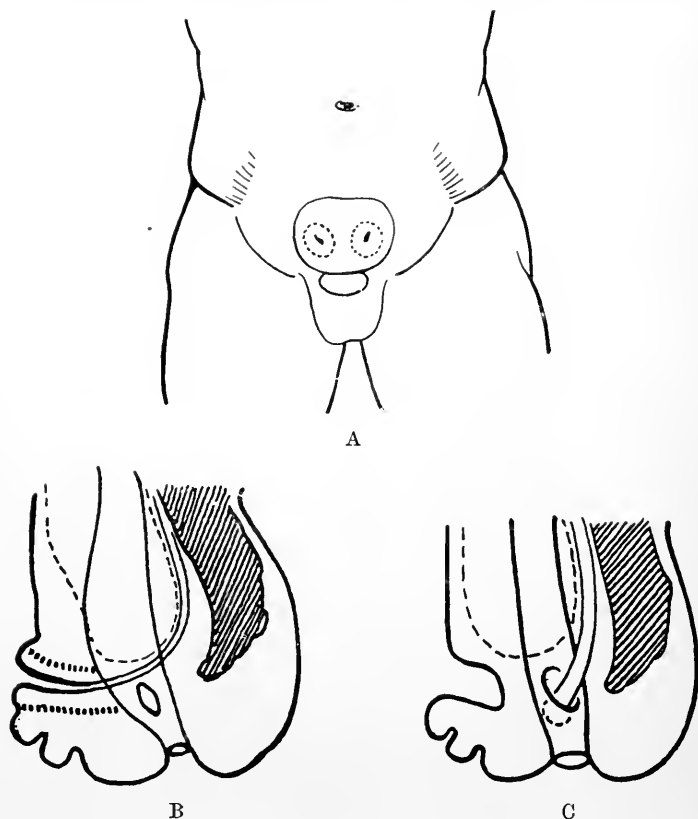
FIG. 192. Ectopia vesicæ. A, Showing position of the ureters and malformed penis. The dotted lines indicate the method of dissecting out the ureters for implantation in the rectum. B, Freeing the ureter. C, Transplanting the ureter into the rectum.

is not satisfactory, since a sphincter cannot be supplied and hence a portable urinal is always needed, while the growth of hair on the flaps at the onset of puberty leads to cystitis and deposits of phosphates. A better plan is to transplant the lower ends of the ureters into the bowel. There are two methods of doing this :

(1) The whole trigone, including the ureteric orifice, is dissected free, rotated and sutured into the sigmoid, which is opened for the purpose (Maydl).

(2) A simpler method (Peters) is to dissect out the lower end of each ureter separately (this is rendered more easy by passing bougies into the orifices) : after freeing the lower ends of the ureters for about two inches

a blunt dissection is made through the pelvic cellular tissue into the rectum and the ureters are inserted into the latter through small slits, the portion of bladder-wall around the ureter preventing its escape. The operation should be entirely extra-peritoneal, when it is very successful, the urine being held in the rectum for several hours at a time. The age for operation is from one to two years. Where the peritoneum is opened accidentally or intentionally the results are less good, as suturing in the latter is not satisfactory in these young subjects.

INJURIES OF THE BLADDER. These may result from sudden violence or over-distension, and even where violence is the determining cause the bladder is usually distended. Violence may be applied to the *outside* of the bladder :

(*a*) By blows or crushes of the hypogastric region when the bladder is full.

(*b*) By penetration of the organ with spicules of bone resulting from fractures of the pelvis or penetrating wounds of the lower abdomen, which may rupture even the empty bladder.

The bladder may be ruptured from *within* by over-distension in washing it out or rough use of catheter, lithotrites, &c., especially if the wall is weakened by chronic distension or softened by inflammation ; hence the need for the greatest gentleness when conducting manipulations within the bladder. Rupture from simple over-distension is uncommon ; where the outflow is blocked by stricture, it is the urethra behind the latter which gives way far more often than the bladder. When the bladder gives way from this cause there is nearly always some diseased condition present as well, such as sacculation and ulceration.

Rupture of the bladder may occur through its upper posterior part into the peritoneum or through the lower surface into the pelvic cellular tissues. Aseptic urine is but slightly irritating to the tissues, and if removed from the peritoneum or cellular tissue within a few hours the damaged parts heal well, but if left for more than twenty-four hours the irritation lowers the vitality of the tissues and they fall a prey to infection with pathogenic organisms from the intestine and elsewhere with peritonitis or pelvic cellulitis, according to the position of the rupture.

In cases where there is already cystitis severe inflammation occurs rapidly. Rupture of the bladder is therefore a very serious accident and needs early diagnosis.

Signs and Diagnosis. The history is usually of some injury to the pelvis or lower abdomen or a punctured wound of this region, the patient having a full bladder at the time. There is marked shock, hypogastric pain, and often a desire to micturate, but nothing passes, or at most some blood in small quantities. When an over-distended bladder ruptures, apart from violence, there is increasing desire to micturate, which suddenly passes off at the moment when the viscus ruptures and returns again gradually as inflammation sets in. On examination, shifting dullness will be found in the loins (where the rupture is into the peritoneum), but where the rupture

is extraperitoneal there will be a fixed swelling increasing in size, which is found above Poupart's ligament on one side.

In all cases with such symptoms or after severe injuries to the pelvis the patient should be asked to pass urine, and if he cannot do so or there is blood in the urine a catheter is passed, and if the urine be blood-stained or small in amount (the patient having previously had a full bladder) further investigation is required. As operation will very likely be needed, the patient should be given morphia gr. ¼ and anæsthetized with open ether. A simple plan is to inject a measured quantity of saline solution (about eight to ten ounces) and then to empty the bladder again ; if the amount returned is much diminished there is probably rupture of the bladder, while shifting dullness in the loin may be made more obvious.

Another plan is to inject air up the catheter, having previously marked out the liver-dullness : if the bladder be ruptured instead of a resonant swelling appearing in the situation of the latter, the liver-dullness becomes obliterated where the rupture is intraperitoneal, or surgical emphysema of the lower-abdomen perineum is found ; caution is needed with this method, as severe shock is sometimes caused by distension of the peritoneal cavity with air. If still in doubt the cystoscope should be passed ; the intact bladder is obvious, as well as bleeding from either ureter, but where nothing can be detected but blood or darkness visible, the bladder is almost certainly ruptured.

Treatment. Operative measures are indicated, and to be successful must be immediate ; if prompt measures are taken the results are very satisfactory, but a delay of over twenty-four hours renders the prognosis grave.

Operation. In any case the peritoneum is opened by a paramedial incision close above the pubes, as it is seldom certain that the peritoneal surface of the bladder is not involved, and if this surface proves to be uninjured the peritoneum is closed.

(*a*) Having found the rupture on the peritoneal surface, the intestines are packed back, all free urine sponged away, and the patient placed in the Trendelenberg position. The rent is then closed with two rows of continuous sutures, the inner being of ordinary catgut, taking up all layers of the bladder but invaginating the mucosa, the outer being of silk and taking up peritoneum only ; a large soft catheter is tied into the bladder (*via* the urethra) and kept in for seven to ten days to avoid leakage of urine. Unless obvious sepsis be present, there is no need to drain the pre-vesical space and the abdomen may be completely closed.

(*b*) Where the peritoneal surface is not injured the peritoneum is closed and pushed up out of the way ; then the front and sides of the bladder are explored through the prevesical space, or if necessary, the bladder opened and explored from inside. The rent, when found, is, if possible, closed with catgut and the prevesical space drained, a catheter being tied in as before. As, however, owing to the depth, it may be impossible to suture the bladder, a large tube should be placed down to the rent, in order to prevent extra-

vasation into the prevesical tissues. The tube should be irrigated daily and removed on the fifth day, when a sufficient track will have become established for the escape of any infective material, and the wound will close like a suprapubic cystotomy. In cases of fractured pelvis loose fragments may be removed or levered into a better position through this incision.

The bladder is sometimes wounded at operation, as may happen in cases of hernia or in hurriedly opening the abdomen without seeing that the bladder is empty (the careful surgeon will not make the latter mistake) ; hence before cutting through doubtful structures in and about the pelvis
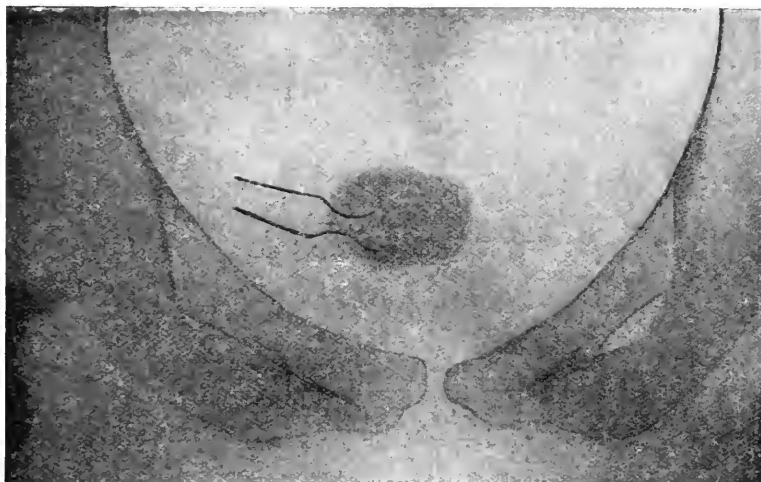
FIG. 193. Vesical calculus in female bladder forming round a hairpin. The bare part of the pin lay within the wall of the bladder.
(*Kindly lent by Mr. Hutchinson.*)

it is well to pass a sound into the bladder and make certain that the structure is not the bladder. Finally, when uncertain as to whether the bladder has been injured at operation the cystoscope is passed to make sure, and if a wound be discovered laparotomy is performed as described and the wound sutured.

FOREIGN BODIES IN THE BLADDER. These are derived from various sources ; they may be introduced by the patient from curiosity or perversity, including such objects as pipe-stems, hairpins, &c., or by the surgeon, such as bits of catheters or bougies, drainage-tubes from cystotomy ; they may result from disease of neighbouring parts, such as sequestra ; bullets are sometimes found. Such bodies may cause no symptoms for a time, but at last they will set up cystitis and be covered with phosphates, while pain, frequency of micturition, and occasionally hæmaturia will be noted. On examining with the cystoscope the object will be seen and, if recently introduced, recognized, but later will simply appear as a phosphatic concretion.

Treatment. Where the foreign body has been recently introduced and is of suitable shape, such as a piece of catheter or hairpin (in the female),

it may be grasped by one end with the lithotrite and thus pulled down the urethra ; but where it is an old inhabitant of the bladder encrusted with phosphates or imbedded in the bladder-wall, or where there is much cystitis, it will be wiser to perform suprapubic cystotomy, as by this method the object can be removed entire without fragments breaking off to form fresh stones, while the drainage set up will improve the cystitis.

VESICAL CALCULUS. Stone in the bladder may result from the descent of a renal calculus or may originate in the bladder. Just as in the kidney, so vesical calculi are divided into : (1) primary, where infection plays a minor part and precipitation of salts from an overcharged urine is the main cause ; while (2) secondary stones are the results of obvious infection and cystitis.

Primary calculi result from stagnation of urine and the deposit of urates or oxalates about some nucleus, such as blood-clots, pieces of mucus, Bilharzia ova, &c. Secondary calculi are the result of alkaline decomposition of the urine due to urea-splitting organisms, and are associated with chronic cystitis. The same varieties are found as in the kidney, viz. uric acid, urate of ammonia, oxalate and phosphate of lime, and the rare cystin, xanthin, and indigo stones.

FIG. 194. Vesical calculus encysted in a pouch.

Causes. The occurrence of stone is much greater in certain districts (India, Egypt, Norfolk), but whether water, climate, food, or a combination of these is responsible is uncertain.

Pouches of the bladder-wall, whether congenital or acquired, are sources of stone. The stagnation of urine in a pouch helps to promote the deposit of salts. Stones thus confined to a pouch are said to be " encysted." Sometimes such stones are fixed in a pouch by one extremity, while the remainder lies free in the bladder (Fig. 194) ; such " dumb-bell " stones may be hard to remove. Stones are relatively common in children under ten and in old men ; they are rare in women, probably owing to the short, wide urethra allowing ready passage of stones while still small, during micturition.

Structure. Bladder-stones consist of a nucleus or central portion which may be a descended renal stone or something derived from the bladder, such as clot or foreign body (fragment of a catheter, a hairpin, &c.). Round the nucleus are concentric layers of crystalline deposit, usually oxalates or urates or alternate layers of these, forming the " body," while a superficial " crust " of friable phosphates of varying thickness may be present. The latter may be absent ; its presence means that infection and cystitis have occurred.

Numbers. One stone or many may be present.

Results. A smooth stone may be long present without causing symptoms ; later the bladder becomes irritated and micturition becomes more

frequent; sometimes the stone blocks the urethra and the stream stops suddenly: as time goes on the constant efforts of the bladder to empty itself causes hypertrophy of its wall, and if there be obstruction to the outlet dilatation of the viscus results, with protrusion of the wall in one or more places as saccules. Still later infection follows, causing cystitis or inflammation and ulceration of the bladder, while rarely perforation may ensue. The infection may spread to the kidney, causing pyelitis, pyelonephritis, &c.

Symptoms. There may be a previous history, sometimes many years before, of renal colic.

Pain. A smooth uric-acid stone will cause no symptoms for a long time in the bladder of adults, but in children, owing to the greater sensitiveness of the part, pain is more usually an early symptom, while a rough oxalate calculus will always cause pain early. The pain is at the neck of the bladder and perineum, and is increased by jolting, relieved by rest. The most characteristic pain is that coming on towards the end of micturition as the stone is forced down on to the sensitive trigone and is felt at the tip of the penis. This pain is severe, and in children screaming during micturition and pulling at the penis to relieve the pain is very strong evidence of stone in the bladder. When the pain radiates to the back and thigh there are probably renal calculi as well.

Increased *frequency* of micturition is usual, and with slight hæmaturia is most marked by day on account of movements.

At times the *stream of urine is cut short* in the middle of micturition by the stone suddenly blocking the internal meatus of the urethra; this, when present, is a very characteristic symptom, as the only other condition which can produce it is a pedunculated tumour of the bladder.

Retention of Urine. The sudden cutting off of the stream may become complete retention in children, the stone completely blocking the urethra. In adults this is less common, since in them the ureter is smaller than the urethra and any stone passing the former will easily pass the latter, whereas in children the urethra is the smaller tube. *Incontinence* from impaction of an irregular stone in the urethra is rare, but false incontinence, *i.e.* retention with overflow, is found in children from continuous partial blocking of the urethra, associated with atony of the bladder. Later the symptoms of *cystitis* are added, viz. pyuria and frequency by night as well as by day; while still later, when the kidneys are affected, fever, thirst, wasting, and loss of appetite are noted, indicating *pyelitis*, &c.

Signs and Diagnosis. Urine. This may be normal or may contain a deposit of crystals of uric acid, oxalates or phosphates, according as it is acid or alkaline; the mere passage of crystals may cause the symptoms of stone, but constant passage of these is very suggestive of the latter. Red corpuscles and pus-cells may be found on microscopical examination.

Rectal and Bimanual Examination. In a good many cases, especially in children, the stone can be caught between the examining fingers by this method and the diagnosis made without more ado.

Radiographs are useful. not merely in detecting a stone in the bladder, but in all cases the loins should be examined as well, as there is little permanent use in removing a stone from the bladder while there is a quarry ready to come down and supply the place of the one removed.

Internal examination of the bladder is made with the *cystoscope* and *sound*, the former being more instructive. Neither should be passed during an " attack of stone," *i.e.* an exacerbation of the symptoms with cystitis ; in this condition the patient should be put to bed and given diuretics and urotropin till the acute condition has passed.

With the cystoscope the size, colour, number, and position of the stones can be determined, while a concretion of phosphates covering an ulcer can be distinguished (with the sound these conditions are likely to be confused), and also associated conditions such as pouches can be detected. To introduce either instrument the patient is placed on the back ; the bladder contains a few ounces of urine, or clear fluid in the case of the cystoscope, (washing out the bladder if necessary). In sensitive subjects the urethra is anæsthetized with novocain and the sterile sound or cystoscope passed after the manner used to introduce a metal catheter. The sound, after being introduced, is rotated from side to side so that the end or " beak " explores the floor and sides all round in turn. A stone is detected by the click as the sound strikes it : a hard, sharp tap denotes an oxalate calculus, a more dull sensation a phosphatic concretion ; some idea can also be formed of the dimensions of the calculus by tracing its circumference with the sound.

Conditions likely to be confused with stone are cancer of the bladder, enlarged prostate, posterior urethritis, tubercle of the bladder, bacilluria and pyelitis, phimosis, crystals in acid urine.

Cancer and *enlargement of the prostate* will cause pain, hæmaturia and frequency, but these are not increased by movements, *i.e.* they are as bad by night as by day ; the cystoscope and rectal examination will distinguish.

With *posterior urethritis* there is pain at the neck of the bladder and tip of the penis with frequency, but the " two-glass test " after washing out the anterior urethra will disclose threads containing gonococci, and thus save the irritation of sounding or cystoscopy.

With *tuberculosis* the pain and frequency are as great by night as by day, while the greater amount of pus, slight amount of blood, and the finding of tubercle bacilli in the urine and tuberculous foci elsewhere (epididymes, prostate, lungs, &c.) will settle the matter without closer investigation of the bladder (*see also* p. 548).

After *circumcision* in children, stone being so common, if there have been any signs of irritation of the bladder, such as pulling the foreskin (which may be due to phimosis or stone), the bladder should be sounded and a bimanual examination made with a finger in the rectum and a hand on the lower abdomen.

Pyelitis and *cystitis* will be separated by the condition of the urine (a haze of bacilli) and by the absence of stone on bimanual examination of the bladder.

Course and Prognosis. Spontaneous expulsion of stones per urethram is uncommon except in the case of small calculi shortly after their descent from the kidney. The course may be very prolonged before cystitis and still later pyelonephritis supervene. Before the latter condition arises the prognosis is good if the patient be otherwise fit and the stone be removed expeditiously. When the kidneys are affected the outlook is worse, though by keeping them well flushed before and after removal many cases of this type do well.

Preventive Treatment. This consists in avoiding stagnation of the urine by removal of enlarged prostates, growths, or pouches of the bladder ; dividing strictures, treating cystitis, and altering or mitigating the reaction of the urine so as to prevent deposits of salts from excessive acidity or alkalinity and in regulating the diet, &c., as indicated under Renal Calculus (p. 529).

Curative treatment consists in removing the stone, either *via* the urethra, and then usually after crushing it (litholapaxy), or by opening the bladder (cystotomy). The former is the ideal method where it is suitable.

(1) REMOVAL OF STONE THROUGH THE URETHRA. (*a*) In women stones up to half an inch in diameter may be removed with forceps through the urethra after dilating the latter ; further dilatation of the urethra is likely to be followed by permanent incontinence of urine.

(*b*) *Crushing Operations.* Formerly the stone was broken up more or less with the lithotrite and the patient allowed to pass the fragments as best he could ; several " sittings " were needed and the results of this plan (lithotrity) were not satisfactory, as fragments which could not escape formed nuclei for fresh stones, and the operation had to be repeated ad infinitum or cystotomy performed. The modern operation (litholapaxy) consists in crushing the stone completely at one attempt under anæsthesia and removing all the fragments with the evacuator of Bigelow, and then seeing with the cystoscope that the bladder is quite clear of fragments.

The advantages of litholapaxy over lithotomy (cystotomy) are :

(*a*) The mortality is lower (in suitable cases).

(*b*) Less time in bed is needed, the patient being up in three to four days, as against two to three weeks with lithotomy.

(*c*) There is no risk of fistula, cellulitis, &c.

The disadvantages are :

(*a*) A greater liability to recurrence from fragments being left in the bladder (the cystoscope should prevent this).

(*b*) The operation takes longer and is certainly more difficult.

(*c*) There is no drainage, which is necessary when cystitis is present.

Litholapaxy is contra-indicated under the following conditions :

(1) Where the prostate is enlarged as well ; in such cases suprapubic cystotomy should be done and the stone removed ; the prostate may be taken at the same time, or left for a few days and removed at a second operation if the condition of the patient is not very favourable.

(2) Where there is severe cystitis.

(3) Where the stone is wholly or partly in a pouch.

(4) In the case of very large or hard stones. For surgeons of ordinary experience the limit of size suitable for crushing is about three ounces, or an inch and a half in diameter in adults, while stones over one ounce should be removed by lithotomy in children under six unless the operator be very expert, when they may be crushed in children of two or three, up to this size. Where the operator has small experience it is best not to attempt to crush stones in children under ten. The size of crushable stones depends largely on the experience of the surgeon.

(5) A contracted bladder holding less than four ounces.

(6) Where there is infection of the kidneys.
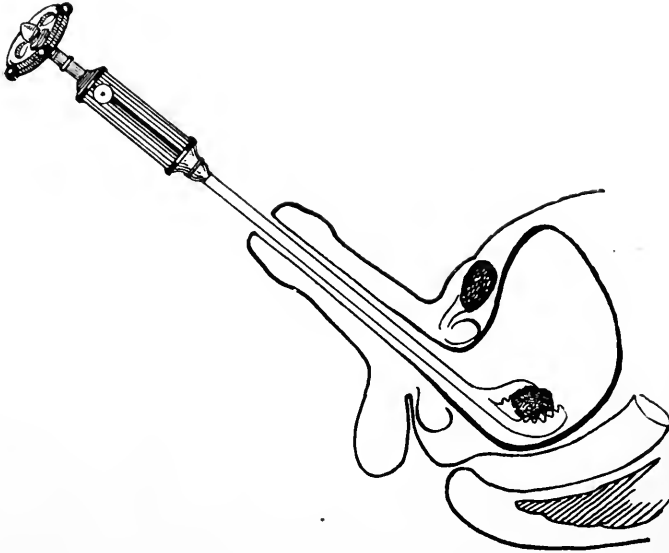
FIG. 195. The lithotrite grasping a vesical calculus.

In all the above conditions lithotomy is indicated.

Litholapaxy. The patient, prepared for a few days by taking diuretics and urotropin, is anæsthetized and placed on the back with the knees slightly bent. The penis and surrounding area are cleansed ; where the urine is clean Contrexeville an hour before the operation will be sufficient, or the bladder may be washed out and filled with eight to ten ounces of oxycyanide of mercury and lotion (1–5000) to obliterate the folds of mucous membrane and render manipulation of the lithrotrite more easy. Thompson's instrument is a good type ; the male blade is solid but the female fenestrated to prevent jamming of fragments of stone, and the surgeon should make himself thoroughly acquainted with the mechanism of locking and unlocking the lithotrite, practising by crushing pieces of chalk before attempting on the living. Strictures may need division before the instrument can be introduced. The male blade moves freely in a groove in the shaft of the instrument until fixed by the catch, when it can be tightened by screwing up the milled head in the handle, exercising in this manner great crushing force

on any stone caught between the blades. The instrument, with the blades closed, is introduced like a silver catheter and then rotated like a sound till the stone is felt. The angle made by the junction of the blades with the shaft is then gently pressed into the floor of the bladder by raising the handle and the blades opened ; a slight lateral movement will induce the stone to fall between the blades, which are then closed and the stone gripped (the imperfect sliding home of the male blade will show that the stone intervenes and give an idea of its size). Before gripping hard the handle should be depressed again to raise the blades and stone, and avoid gripping the mucosa, as any interference to this manœuvre will show that the mucosa is caught, and the blades must be relaxed and another grip taken. When the stone is gripped without intervention of the bladder-wall the catch is slid home and the handle screwed up. A resistance is felt, which suddenly
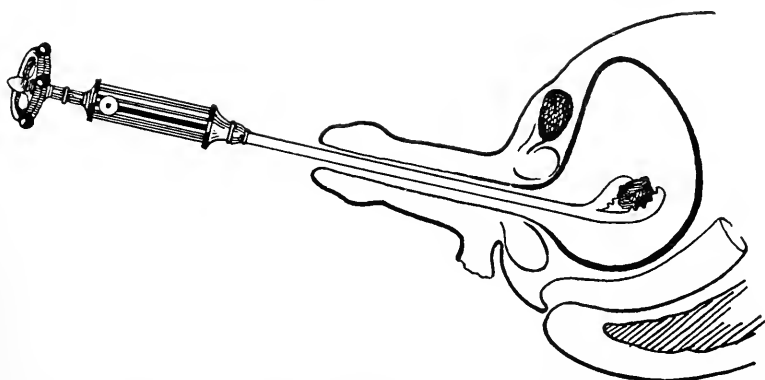
FIG. 196   Lithotrite in position with the stone grasped and lifted off the floor of the bladder (to be certain that no mucosa is picked up).

yields, perhaps with an audible crack, as the stone breaks. This process is repeated with the fragments till they are reduced to a size small enough to pass along the tube of the evacuator. If the stone cannot be caught in this manner the blades are rotated from side to side, well opened and closed to grasp the stone, or even turned round so that the beak points to the floor of the bladder. All movements must be done gently and care taken not to injure the wall of the bladder. When the surgeon considers that the fragments are sufficiently small the largest tube of the evacuator is passed (slitting the meatus if necessary). The evacuating bulb, completely filled with lotion, is fitted on the end of the tube and the rubber part gently squeezed and then smartly released, so that the rush of water carries with it fragments of the stone, which fall into the glass receiver at the bottom of the evacuator. The tube is directed to various parts of the bladder-floor, till the cessation of taps on the tube when the rubber bulb is relaxed indicates that all fragments are inside the evacuator, and the cystoscope is passed to make sure that nothing is left. The patient is kept warm in bed and given plenty of warm, bland drinks, such as barley-water, weak tea, and gin, if stimulant be needed ; urotropin is continued and morphia

is occasionally needed for pain. Retention of urine may follow, rendering catheterization necessary. The patient can get up in from two to seven days, according to his progress and the condition of the urine.

Complications. Cystitis of varying intensity may follow; lavage will cure the milder cases, but if very severe, as where the mucosa has been torn, the bladder should be opened and drained.

Accidents. Rarely the instrument breaks or becomes clogged so that it cannot be removed; in such cases the bladder must be opened above the
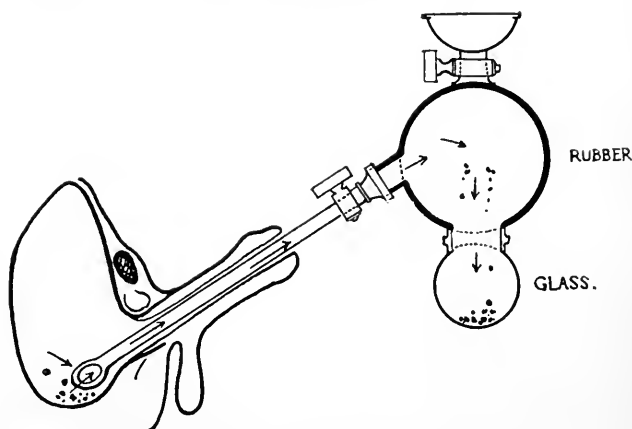
Fig. 197.   Removing crushed fragments of a vesical calculus with the evacuator.

pubis, the blades pushed out and cleared, or, if this be not sufficient, filed off and the shaft pulled out of the urethra.

Atony of the bladder is another uncommon sequel; regular catheterization and the administration of strychnine are indicated.

(2) LITHOTOMY. The bladder may be opened for removal of stones, either through the perineum or above the pubis; the latter is the method of election in nearly all cases.

(a) *Suprapubic Lithotomy or Cystotomy.* The preliminary treatment is as for litholopaxy. General anæsthesia may be employed, but for old men intraspinal anæsthesia is advisable.

The patient lies on the back with the pelvis slightly raised. The bladder is distended with ten ounces of fluid in adults, three to four in children, and a vertical, paramedial incision is made immediately above the pubis of two to three inches in length, the rectus-sheath opened, the recti separated, and the prevesical cellular tissue opened. The peritoneum is pushed up out of the way if the distension of the bladder has not already forced it up: it may be noted that the peritoneum does not always ascend as much as might be expected, and if inadvertently cut it should be closed with a continuous suture of fine silk and no harm is done. The front of the bladder is recognized by the interlacing, reddish muscle-fibres which form its wall. A pair of sutures are passed through the bladder-wall, one on either side, to act as slings and prevent too great retraction of the organ, as the latter

contracts after being opened. The bladder is opened in the middle line and the fluid escapes ; a finger is inserted and the stone or stones felt and extracted with suitable forceps or scoops, enlarging the incision if necessary so as not to bruise the edges of the incision. The interior of the bladder is explored for pouches or enlargement of the prostate. The latter may be removed at once if the patient's condition be good, but if doubtful the bladder should be drained for a few days first. Where the stone is in a saccule it may be possible to remove with forceps after nicking the edge of the pouch. If necessary, the stone may be crushed or broken up with chisel and mallet, taking care to steady the stone so that no undue violence is applied to the bladder : the finger of an assistant in the rectum serves for this purpose.

Where the bladder-wall is healthy it may be sutured with catgut, inverting the mucosa, and the bladder drained by catheter for a week, placing a tube in the prevesical space for four days to form a track in case leakage occurs, but as a rule such cases heal well. Where there is cystitis the bladder should be drained with a fair-sized tube, the wall being only partially closed. The tube should not reach the floor of the bladder lest it cause ulceration. The tube should be retained about a week and irrigation made daily ; after this the tube is removed and irrigation carried out per urethram, the suprapubic wound healing in from two to six weeks.

To keep the patient dry, the tortoise dressing of Irvine applied over the suprapubic wound is most convenient.

Suprapubic cystotomy is the easiest and safest method of dealing with stone of the bladder where litholapaxy is contra-indicated, except :

(1) Where the bladder is greatly contracted so that it may be difficult to approach from above the pubis.

(2) Where the stone is impacted in the prostate it may be impossible to reach from above, and the perineal route is indicated.

(b) *Perineal Lithotomy.* Formerly lateral perineal lithotomy was the operation par excellence for all stones of the bladder ; it is now practically obsolete, and the median route is recommended for the few cases where the attack is made from the perineum.

Median Perineal Lithotomy and Lithotrity. The patient is in the lithotomy position, the perineum shaved and cleansed. The bladder is filled with as much fluid as it will hold and a curved staff grooved on its lower surface is introduced. A two-inch incision starts just in front of the central point of the perineum and ends half an inch in front of the anus, hitting off the staff at the junction of the prostatic with the membranous part of the urethra ; the knife is run along the staff into the bladder and the prostatic urethra partly incised and in part gently dilated with the gorget, no tearing being permissible. The stone, if small, is extracted with forceps, but if so large that there is danger of tearing the neck of the bladder by forcible extraction, is crushed with a lithotrite (specially large sizes can be introduced in this way (Keegan)), and removed with the evacuator. The interior of the bladder is explored with the finger, and enlargement of the prostate may be dealt with at the same time. Perineal lithotomy is advised by some

where there is much cystitis, but the results of the suprapubic operations are extremely good. After removing a stone *via* the perineum a drain-tube is inserted into the bladder and irrigation carried out twice daily; the tube is removed in five days and the wound irrigated till it heals.

LITHOTOMY IN WOMEN. Where the stone is too large to be removed by dilating the urethra it should be treated by litholopaxy, but if too large to be crushed, removal by suprapubic lithotomy is advisable. Removal by opening the bladder from the vagina is likely to lead to that troublesome condition vesico-vaginal fistula.

INFLAMMATIONS AND INFECTIONS OF THE BLADDER ; CYSTITIS. Inflammations of the bladder are nearly always of infective origin ; simple mechanical irritation, such as the presence of a stone or other foreign body, does indeed cause congestion and probably exudation from the part of the bladder on which it lies, but of such small degree as not to produce symptoms, though the difference in appearance of the bladder may be noted with the cystoscope. The action of infective organisms may be greatly enhanced by means of their decomposition-products, *e.g.* in the production of ammonia by the urea-splitting organisms. Matters causing cystitis are mechanical, such as foreign bodies, chemical as toxines, and organic, including bacteria and parasites, such as the Bilharzia worm. The presence of organisms in the bladder is not enough to cause cystitis, at any rate to marked extent ; other concomitants are needed, as :

(1) Injury, which may be slight, such as the presence of stone or growth, or gross, as the pressure of the fœtal head during labour, which may cause sloughing cystitis, &c.

(2) Stagnation of the urine, as from strictures or enlargements of the prostate.

(3) Alterations of the urine and blood, as in diabetes and renal disease.

(4) Irritating drugs, such as cantharides, copaiba, &c.

(5) Loss of nervous control (*e.g.* fractures of the spine) involves not merely stagnation of the urine, but also repeated sources of possible infection, viz. the imperfectly cleaned urethra, penis, and catheter.

(7) Irritation by bacterial products such as ammonia.

(8) Congestion from cold and alcohol also seems to be a determining factor in many instances.

Sources of Infection. (1) Organisms may advance up the urethra either spontaneously or as the result of instrumentation, and spread rapidly against the stream of urine, most probably not ascending the interior of the urethra at all but travelling in the lymphatics.

(2) They may be carried down from the kidney ;

(3) Or be carried by the blood, as in primary tuberculosis of the bladder ;

(4) Or spread from neighbouring organs, *e.g.* coli cystitis from the intestines or tubercle spreading from the prostate or seminal vesicles.

Various organisms are responsible for the production of cystitis. The tubercle bacillus is placed by itself, the effects of the others are grouped together under the term cystitis ; these organisms are the staphylococcus,

streptococcus, colon, and proteus bacilli, &c. The colon bacillus is the most common, the staphylococcus and proteus next, while streptococci and gonococci are not common.

Anatomy. The whole of the mucosa of the bladder may be affected, but the affection is more commonly confined to certain localities, especially the trigone and ureteric orifices.

(a) In the *acute* stage the interior of the bladder becomes red and hyperæmic, the epithelium becomes sodden and desquamates, sometimes being previously raised in bullæ (bullous cystitis). As the epithelium is shed the mucosa looks red, velvety, and is covered with shreds of thick mucus, muco-pus and desquamated epithelium. The infection may spread to the submucosa, causing ulceration or interstitial abscess of the bladder-wall : perforation and peritonitis are uncommon sequelæ. In the earlier stages the process may subside and the bladder return to its normal state, but if there is organization of exudate in the wall of the bladder contraction of the organ will result (Fig. 198). In severe cases the entire mucosa may be shed, coming away as a membrane (membranous cystitis).

Fig. 198. Contracted and thickened bladder (thimble bladder).

(b) In *chronic* cases the process may be localized or diffused over the inside or through the wall of the bladder. The inside of the bladder is hyperæmic, the epithelium looks dull and whitish-grey or stained by applications of silver nitrate. Patches of red granulations and polypoid excrescences are seen, while flakes of pus and epithelial debris cling to the wall and phosphatic concretions cover the ulcerated spots. The interstitial part of the wall undergoes important changes ; there are degeneration of some of the muscle-fibres and hypertrophy of others, so that the bladder is surrounded by interlacing bands, giving it a " trabeculated " appearance. There are consequent thickening and loss of elasticity of the wall, which gives way between the trabeculæ (from the increased internal pressure, due to blocking of the outlet, which is usually present), and thus pouches are formed which contain phosphatic concretions. The bladder may be contracted down to a capacity of one or two ounces, and as the peritoneal reflection is drawn down as well, it may be below the top of the pubis, which is of importance when a suprapubic cystotomy is in question. Perforation occurs rarely, from ulceration and distension ; the cellular tissue around the bladder is also fibrous and contracted.

Signs. ACUTE CYSTITIS. The classic signs of cystitis, pain, pus, and frequency are here exaggerated. The pain is severe in the hypogastrium and perineum during the intervals of rest, but rises to agony during the frequent acts of micturition, which may occur every few minutes. The pain then is at the neck of the bladder, behind the pubes, and along the penis ; the desire to micturate is intense and the pain of doing so no less. The urine voided is turbid from small amounts of pus, and at the end of

micturition a drop of blood may be squeezed out : such is " strangury."
Constitutional signs are absent unless the condition is very severe with
sloughing, &c., when fever, rigors and depression may occur. The urine may
be acid or alkaline and ammoniacal ; there is never a large amount of pus.
The tense bladder may be felt per rectum and is not to be confused with
an enlarged prostate. In a few instances profuse hæmorrhage is the main
symptom, which may be so severe as to lead to clotting in the bladder and
cause retention, though the pain and frequency are not marked ; such a
condition may be called " cystostaxis " on the analogy of the similar gastro-
staxis of the stomach.

Treatment. Rest in bed, hot fomentations to the hypogastrium, hot
hip-baths, and suppositories of morphia and belladonna are indicated to
relieve the pain. The diet should be liquid, of milk, barley-water, and
bland fluids, alkaline diuretic water such as Contrexeville, &c. ; the bowels
should be kept open with salines and hot enemata may afford great relief.
Of drugs, citrate of potash grs. 20, with tincture of hyoscyamus minims 20,
and infusion of buchu to the half-ounce, given every four hours, is of service,
and to this should be added five grains of urotropin when the more acute
stage has passed. Where the urine is alkaline and ammoniacal, acid-
sodium phosphate in half-drachm doses should be administered. The use
of instruments should be avoided, as causing further irritation ; should,
however, the condition be ultra-acute, as will be suspected from the passage
of sloughs in very foul urine, the bladder should be opened from the
perineum and irrigated twice daily, though such cases are not likely to
survive.

CHRONIC CYSTITIS. In this, the more common condition, the symptoms
are similar but milder. The frequency is perhaps hourly or less often,
the pain is moderate, and the pus considerable in amount and mixed with
mucus and phosphates. This condition may be the sequel of acute cystitis
or arise insidiously from the first. Later the bladder will be small, holding
but few ounces of urine.

Diagnosis. This consists in settling whether the pus comes from the
kidney (pyelitis) or lower (posterior urethritis). From *pyelitis* the diagnosis
may present difficulties, and it is good policy to suspect all cases of chronic
cystitis of unknown origin of being pyelitis till the contrary is proved.
Pain, pyuria, and frequency occur in both, but fever, which is rare with
cystitis, is the rule with pyelitis ; an onset with hæmaturia suggests pyelitis.
In pyelitis the urine is acid and the pus forms a more definite layer at the
bottom of a specimen glass and is greater in amount than in cystitis. The
enlarged, tender kidney may be palpable, while radiographs will reveal
enlargement of the organ or a calculus ; finally, when the condition is
quiescent the cystoscope shows a jet of pus from one or both ureters.

A *posterior urethritis* is distinguished by the " two-glass test " after
washing out the anterior urethra : in this affection the first glass contains
turbid urine with " threads," the second glass is clear ; in the case of cystitis
both glasses contain turbid urine, the second being the more purulent.

The organisms found in the pus of urethritis are gonococci ; these are seldom found with cystitis.

The diagnosis is not complete till the infecting organism is isolated from catheter specimens of the urine, and this may be useful in order to provide vaccines. Finally, the predisposing cause should be found, such as calculus, enlarged prostate, urethritis, stricture, &c.

Treatment. (*a*) *Preventive.* This consists in carrying out the axioms of urinary and general surgery, viz. gentleness in passage of instruments and other manipulations ; extreme care as regards asepsis of instruments and the urethra ; removing causes or obstruction to the outflow of urine ; treating glycosuria, nervous disorders, &c. ; early removal of calculi and growths.

(*b*) *Curative.* Once the condition is definitely out of the acute stage there is no longer need for rest in bed ; indeed mild exercise and fresh air are beneficial. The diet should be abundant but not irritating ; alcohol. spices, or highly seasoned food are avoided—fish, fowl, and milk being given the preference. Drugs should be diuretic and antiseptic. Plenty of water by mouth is the first requisite, and where the urine is alkaline, acid-sodium phosphate, half a drachm combined with five grains of urotropin thrice daily, is excellent. In the later stages sandal-wool oil is advised in ten-minim doses thrice daily, especially where there is much mucus, but not if it readily upsets the stomach or causes irritation. Lavage or washing out the bladder forms an important part of the treatment in these cases, as this removes pus, &c., mechanically, while dilute antiseptics are applied to the interior of the bladder, and the distension caused as the bladder is filled tends to increase the capacity of the organ, which, as has been pointed out, is likely to shrink from interstitial fibrosis. Lavage can be used by inserting a soft rubber catheter to which a douche-can (irrigator) is attached by a nozzle and a length of tubing. The bladder is filled from the irrigator (a fall of two feet is enough) till the patient feels that the bladder is full, and after a few minutes emptied again through the catheter ; the process is repeated till the wash comes back clear. The following solutions are useful : saturated solution of boric acid (astringent and mildly bactericidal), oxycyanate of mercury 1 in 4000 (non-poisonous and a good antiseptic), potassium or zinc permanganate 1 in 4000–2000 (astringent and antiseptic), silver nitrate 1 in 5000–10,000 (astringent and antiseptic).

In most instances lavage should be performed once daily.

Instillation is a method used for introducing small quantities of stronger solutions into the deep urethra and trigone of the bladder, and is often efficacious. A catheter lubricated with glycerin is introduced an inch beyond the compressor-urethræ muscle and then with a small syringe half a drachm of the instillation introduced. The patient is put in bed before the instillation and pain relieved with hot baths. The following solutions are used : silver nitrate 8 grains to the ounce, increasing gradually up to 40 grains ; protargol 5 to 15 per cent.

In severe and rebellious cases, especially where ulceration is present,

suprapubic cystotomy should be done, the interior of the bladder examined, and ulcers treated with strong silver nitrate, while lavage through the suprapubic opening should be carried out for several days : a tortoise dressing over the wound keeps the bed dry and the patient comfortable.

Strictures, calculi, &c., of course, should be treated. In obstinate cases vaccines prepared from the patient's purulent urine are worth a trial. Perineal cystotomy is less desirable owing to the inferior access it affords and the dangers of deep hæmorrhage, wounding the rectum and pelvic cellulitis.

TUBERCULOSIS OF THE BLADDER. Infection of the tubercle bacillus rarely affects the bladder first of the genito-urinary system, and when this hæmatogenous infection occurs it lands in the upper posterior part of the organ. More commonly the infection is secondary to tuberculosis of the kidney or epididymis (not passing along in the urine or semen but spreading in the lymphatics which surround the ureter or vas), and so arriving at the bladder-wall (some maintain that the most usual primary focus is in the prostate). The disease is most common in young males ; whether the infection has any connexion with a past gonorrhœa is highly problematical, since a gonorrhœa is included in the past history of most veracious males.

Anatomy. The tubercles start as submucous infiltrations round the ureter (when secondary to the kidney) or to its outer side (when consecutive to epididymal infection). The raised red patches soon break down by caseation, to form ulcers which coalesce, appearing as yellow patches.

The ulcers are covered with small sloughs, pus, or exuberant polypoid masses of granulation tissue, round which scattered grey or yellow tubercles may be seen. The process may spread through the wall, causing perforation, but more usually sclerosis of the bladder-wall and contraction results, the organ shrinking to the size of a thimble. The ulceration may spread to the urethra and in the female even to the vulva, forming a tender mass of granulation tissue. Secondary infection takes place later, with increased ulceration and deposit of phosphates. This affection may be extremely chronic, lasting for years, with remission of symptoms at intervals.

Symptoms and Signs. The cardinal symptoms are pain on micturition, referred to the deep urethra and glans penis, and frequency, which is present by night as well as by day. Hæmaturia is exceptional except in cases secondary to tubercle of the epididymis, when a smart attack of hæmaturia may be the initial symptom. The urine is pale and increased in amount and may be clear, but fairly soon becomes opalescent, with flakes and shreds and, later, a marked deposit of pus. The amount of pus and attacks of pain vary from time to time, increasing as the submucous infiltrations burst into ulcers, and subsiding in part again as the ulcers acquire a certain chronicity. This intermission of symptoms is characteristic of tubercle and may arouse false hopes of cure. Red corpuscles may be present in small quantities as well as the tubercle bacillus, though unless pus as well as the bacilli are present, local disease cannot with certainty be diagnosed. The finding of a craggy epididymis, with thickening and nodules in the vas,

vesiculæ and prostate, or an enlarged tender kidney, helps to confirm the diagnosis, while the cystoscope will show the presence of ulceration.

The diagnosis turns mainly on ascertaining the nature of the infection, *i.e.* excluding the colon bacillus, gonococcus, &c., and ruling out infection of the deep urethra and kidney. Bacteriological examination of catheter specimens of the urine and reference to the remarks on the diagnosis of cystitis will help to clear the ground. Stone, simple ulcer, and bilharzia infection may cause confusion in men, while in women renal infection with the colon bacillus gives similar symptoms.

Course. Where the primary focus can be removed (*e.g.* a tuberculous kidney) a small focus in the bladder will usually heal. Otherwise the course is progressively downward but with varying speed. Some cases drag on for years till the bladder is contracted and incontinence, back-pressure, and uræmia close the scene ; in other instances there is a more rapid spread, fistulæ, phthisis, tuberculous peritonitis and secondary infection taking the patient off in a few months.

Treatment. The general hygiene for tuberculosis should be adopted : fresh air, sunshine, fatty food, moderate exercise, and cod-liver oil. The primary focus should be removed (*e.g.*, kidney or epididymis), when early tubercle of the bladder will heal. Where there is much ulceration, sandal-oil and tuberculin may be given, the latter with care, noting the effect on pain and frequency, and occasionally examining with the cystoscope. The dose of tuberculin commences with $\frac{1}{10000}$ milligram, increasing up to $\frac{1}{1000}$ or stronger.

Fig. 199. Ovum of Bilharzia hæmatobia (magnified).

Local treatment is generally inadvisable, but good results are claimed by Rovsing, who washes out the bladder with 50 c.c. of 5 per cent. carbolic acid till the wash comes back clear and leaves the bladder empty. Much pain is caused, rendering hot baths and morphia necessary. This method is continued weekly till the pus and organisms disappear.

Cystotomy and painting the ulcers with pure carbolic is also advised.

BILHARZIA INFECTION. This parasitic worm living in the waters of Egypt, South Africa, and Arabia, obtains entry to the portal and other veins of men ; the ova are discharged from the bladder. The embryos develop in water and it appears that they enter their host through the skin of the legs or urethra and not in drinking-water. The worms mature in the portal vein and migrate into the small vesical and rectal veins to discharge their ova, which they do into the bladder or rectum and so the cycle is repeated without intervention of an intermediate host. The extrusion of the ova produces small ulcers or bleeding-points in the wall of the bladder or rectum which may run together, forming ulcers of some size or granulation masses ; phosphatic concretions form on these and stones are produced ; pyelitis and pyelonephritis may follow. If the patient be removed

from sources of infection the worms die after three to four years and the disease is cured.

Symptoms. Painless hæmaturia results from the penetration of the bladder-wall by the ova, which are ovoid, one-tenth of a millimetre long, and have a sharp spine at one end. Where secondary infection results there will be signs of cystitis or stone. The diagnosis is made by cystoscopic examination. Patches of hyperæmia are seen dotted with white spots, which are the tails of the worms. The ova are recognized under the microscope, while there is a history of residence in one of the above localities. The prognosis is good if the infected district be left.

The administration of methylene-blue grs. $\frac{1}{3}$ twice a week or 15-minim doses of extract of male-fern are said to be helpful, but the evidence is not convincing.

Secondary infections and stone are treated in the usual manner.

ULCERATION OF THE BLADDER. Ulceration may be caused by the pressure of stones, drain-tubes, &c., or occur in the course of cystitis, tuberculosis, and malignant growths. There remain to be considered the simple ulcer and the painful ulcer or fissure. The *simple ulcer* (Fenwick) is found on the posterior surface of the bladder to the inner side of the ureteric orifice. It is clean-cut with healthy surroundings and when first noted may be the size of a shilling, but spreads, and in healing contracts, leaving a shrunken bladder. The condition is found in young males without venereal history. There is pain on micturition, frequency by night and day, and occasionally hæmaturia. No tubercle bacilli are found in the urine or other tuberculous foci in the body.

Treatment. This is as for cystitis, and if this fails the bladder is washed out with 3 per cent. solution of lactic acid; should this be not enough, the bladder is opened above the pubes and the ulcer painted with 5 per cent. silver nitrate. Ulceration arising during cystitis is treated on similar lines. The *painful ulcer* or *fissure* is a crack-ulcer found at the neck of the bladder (internal meatus of the urethra), causing pain on micturition. The crack is visible with the cystoscope, and is treated by instilling 5 per cent. silver nitrate into the deep urethra and bladder.

DIVERTICULA AND POUCHES OF THE BLADDER. A *pouch* has a wide opening into the bladder, while a *diverticulum* has a relatively narrow aperture. These protrusions may be congenital or acquired. Congenital diverticula are found in young males with no urethral obstruction, situated at the outer side of the ureter or above at the apex (urachus). Acquired diverticula are herniæ of the wall between the muscles, commonly secondary to enlarged prostate, less often to stricture; the mucosa is forced between the interlacing trabeculæ. The wall of the diverticulum has but little, if any, muscle in its coat, and hence cannot be emptied, so that stagnation and calculi result as well as infections, since the diverticulum cannot well be washed out; the pressure of a large diverticulum may obstruct the ureter or urethra.

Signs and Diagnosis. The smaller diverticula are only discovered with the cystoscope. The larger forms may present as abdominal tumours which suddenly disappear with passage of much urine. In other cases frequency by day and night leads to the discovery of residual urine on catheterization, although there is no urethral obstruction. In other examples the signs suggest stone, cystitis, hydronephrosis, or urethral obstruction. The final diagnosis is made by cystoscope or, after injecting collargol, by taking radiographs.

Treatment. When a large congenital sac is discovered accidentally the surgeon may hesitate to advise operation, but as the condition is sure to cause trouble sooner or later operation should be advocated. The best plan is to enucleate the sac by suprapubic operation, proceeding outside or inside the peritoneum according to its position ; the sac is then removed and the resulting aperture sutured in layers, inverting the mucosa.

In the case of acquired pouches in old men with deficient renal power, stones should be removed and the neck of the sac enlarged by cutting and dilatation, which is at best merely palliation.

New Growths of the Bladder. These are uncommon before thirty and in children quite rare, being in these young subjects sarcomas and myxo-sarcomas, rapidly growing and inoperable. The tumours found in adults, when occurring over forty, are nearly always malignant, though often appearing innocent for considerable periods. The epithelial type is the only form at all common, and appears as papillomas, which may be innocent or malignant, and sessile forms, which are always malignant. Several varieties are to be recognized :

(1) The *pedunculated, villous* growth consists of feathery, elongate papillæ radiating from a narrow pedicle and covered with transitional bladder epithelium. These tumours may be single or multiple, and often originate close to the orifice of the ureter, which they may obstruct by dragging and so cause hydronephrosis. In young persons these are usually innocent, but after middle age invasion of the basement membrane by the epithelium and malignancy are common.

(2) *Pedunculated, smooth* tumours are occasionally found which are malignant.

(3) *Sessile* tumours may be covered with villi resembling the villous form, or the surface may be smooth ; in either case the epithelial elements soon invade the base, and these forms are malignant.

(4) Where *ulceration* has taken place we find (*a*) the fungating, ulcerating type, which forms a large mass of fungating granulations projecting into the bladder with an infiltrated base, and (*b*) the infiltrating ulcer, in which there is an excavated ulcer with indurated base, everted margins, and sloughy floor. The malignant varieties spread as follows :

(1) Secondaries by " contact " arise from the tumour touching another part of the bladder-wall at some distance, when the bladder is empty, or by " seeding " of cells detached, which give rise to small secondaries.

(2) The local spread is along the connective tissue of the bladder and

pelvic cellular tissue, and in this manner the growth may invade the rectum.

(3) The lymphatic spread is into the glands, along the internal and common iliacs and at the bifurcation of the aorta. The rate of spread to these glands is variable, and is generally less rapid in the more pedunculated forms.

(4) Secondary infection of the lungs and liver *via* the blood occurs late.

Symptoms and Signs. After a varying period of latency the earliest symptom in the pedunculated varieties is painless hæmaturia. The hæmorrhage is free, lasting a few hours or days, and then ceases. This cessation should not be regarded as a cure, but further investigation with the cystoscope carried out, lest the favourable time for removing the growth be allowed to slip by. The attacks of bleeding recur at intervals for years in the innocent form, and hæmorrhage is most marked at the end of micturition and increased by the passage of instruments. Where the growth is innocent

Fig. 200. Bladder tumours. I, Infiltrating vesical growth, *a*, felt per rectum. *b*, Pubis. *c*, Sacrum. II. *a*, Villous growth (pedunculated). *b*, Villous growth sessile.

this stage may last a long time with but little general effect on the patient unless the bleeding be severe enough to produce anæmia, as usually happens later, since the bleedings become greater as the tumour grows. Occasionally the stream of urine is cut off suddenly by the pedunculated growth falling into the internal urethral meatus. Later, when the tumour becomes malignant and infiltrates the bladder-wall, the urine becomes infected and cystitis results with pain and frequency, pus and debris being mixed with the urine, and the hæmorrhage becomes constant. The infection spreads to the kidney and the patient succumbs to a combination of anæmia, sepsis, and uræmia.

Where the growth is ulcerating and fungating, pain, frequency, and pyuria may come on at the commencement with the hæmaturia, though even in these cases painless bleeding may be the initial sign, and the bleeding is more inclined to be continuous without periods of freedom, but cystitis soon follows in these cases.

In the innocent form the urine is clear between hæmorrhages, but fragments of growth may break off and be recognized under the microscope.

When infection supervenes the urine contains pus and blood and debris and may be alkaline or ammoniacal.

Bimanual examination with a finger in the rectum will reveal nothing in the smaller pedunculated growths, but the larger sort can be felt as soft masses inside the empty bladder, and where infiltration occurs a cake-like mass is felt in the wall of the bladder above the prostate. Still later pain down the legs points to involvement of the sacral nerves. The cysto-scope makes the final diagnosis, but where an infiltrating growth can be felt per rectum, together with hæmaturia, pain and cystitis, the employment of the cystoscope only leads to the danger of further infection and may well be omitted. When bleeding is actually present a few days' rest on Contrexe-ville and urotropin should be given to clear and purify the urine, and the patient is cystoscoped in his own urine. This is less likely to cause great bleeding than preliminary lavage. The bladder should contain twelve ounces or folds of mucosa may obscure the view and be confused with growth. In cases with profuse hæmaturia, if the bladder cannot be washed clear the hæmorrhage is certainly of vesical origin, while fragments of growth may break off and help to make the diagnosis where the tumour is too large to permit of cystoscopy.

Diagnosis. Painless hæmaturia may occur in old men from congestion of the prostate, in young men from urethritis, and in both occasionally from cystitis. Malignant or tuberculous disease of the kidney and granular kidney may lead to bleeding, which is sometimes abundant. Cystoscopic examination, finding of tubercle bacilli, and the cardio-vascular changes will make matters clear. The varieties of growth are thus distinguished. Innocent tumours are known by their chronicity, *i.e.* after several attacks of hæmaturia there is no pain, frequency, or pyuria ; the tumour is small, pedunculated, and the surface villous, never smooth ; the pedicle is thin, and movable on the bladder-wall ; the age is under forty. Of malignant forms, the sessile villous, and smooth pedunculated types show more frequent hæmorrhages, recurring at intervals of months instead of years, and the tumour within a year or two is large enough to be felt bimanually, the pedicle is thicker, fixed to the bladder-wall, and the age is over forty : cystitis is usual after a year or so. The infiltrating growths cause hæmaturia from the onset, which is slight but does not intermit ; pain and cystitis are often present from the first ; infiltration of the bladder-wall is felt per rectum ; the ulcer is single, with a hard edge.

Prognosis, apart from operation, is inevitably downward. The villous form may take up to twenty years to destroy life, while the ulcerating forms kill in as many months. If left long enough innocent growths take on infiltrating properties in many instances. The prognosis after operation is not too good. Cure after removal of papillomas amounts to between 25 and 75 per cent., but after resection, for infiltrating tumours, only to from 6 to 12 per cent.

Treatment. Palliative Measures. These should only be adopted as a preliminary to more radical measures or where the latter are out of the

question, but never because a diagnosis has been left unmade ; in other words, no cases of hæmaturia of unexplained origin should be long in the surgeon's hands before the bladder is properly investigated and tumours excluded. To check bleeding, rest in bed, diuretics, ergot hypodermically, and lavage with adrenalin in severe instances will generally suffice. Infection is avoided by employing as little instrumentation as possible and the use of urotropin. Pain when severe, may be controlled by morphia, by drainage of the bladder, or by diverting the ureters on to the loins (ureterostomy), thus lessening the irritation of the growth by the urine.

Operative Treatment. Radical measures are contra-indicated under the following circumstances :

(1) Where the growth is infiltrating the surrounding tissues outside the bladder.

(2) Where there are secondary deposits in the viscera.

(3) When there is severe pyelitis secondary to cystitis, or

(4) Renal inadequacy or other general weakness too great to warrant major operation. The operations in vogue at present are (1) removal of papillomas by cystotomy, (2) removal of the growth with more or less of the bladder, partial or complete cystectomy.

(1) Intravesical removal of papillomas is suitable in the case of pedunculated, villous growths in young persons, where the condition, for the reasons mentioned above, is pretty certainly innocent. The bladder is opened above the pubes as in suprapubic lithotomy and exploration made. The growth is seized with forceps, pulled out till the pedicle is elongated at the expense of the mucosa, and then cut off with scissors, the result being that a considerable area of mucosa and submucosa is removed with the tumour : bleeding-points are tied, and the wound in the mucosa closed with fine sutures of plain catgut. If there be much bleeding a Ferguson's speculum is inserted, the bleeding surface dried and swabbed with adrenalin, or where this fails pressure-forceps left on the bleeding-point for twenty-four hours, the handles protruding from the suprapubic opening. Examination is made for multiple growths and the interior of the viscus is swabbed out with 5 per cent. silver nitrate to kill off any " seedlings " or minute secondaries from the original tumour which may escape macroscopic examination. The suprapubic wound is drained four days, the bladder irrigated and then allowed to heal. Of late diathermy has been employed to cause these growths to wither up ; this is applied under guidance of vision by means of an apparatus combined with a cystoscope, and favourable results are reported.

(2) Where the tumour is sessile or the pedicle is hard and there is invasion of the bladder-wall with short history and early cystitis, treatment on the above lines will never be radical but may be adopted (or the tumour may be curetted away) where the prospect of a larger operation ending fatally is considerable, since such local removal will often give great relief for several months. Where the patient's condition is good cystectomy should be practised.

(a) *Partial Cystectomy.* This method is suitable for small sessile, single growths or infiltrated ulcers. The bladder is explored by suprapubic cystotomy, and where the growth is on the anterior surface or apex of the organ it may be possible to remove it without opening the peritoneum, which is stripped back well clear of the growth ; the growth is cut away with a good margin of bladder-wall around ; the aperture is sutured with catgut and suprapubic drainage established. Where the posterior surface or trigone is affected the bladder is dried out, the peritoneum opened, and intestines packed off, and the recti may be divided transversely to give more room. The bladder is dissected free from surroundings over the growth and freely removed. If the growth involves the lower end of the ureter the latter is cut across outside the bladder and reinserted through a slit in the upper surface of the reconstructed bladder. The bladder-wall is closed with catgut, the peritoneal opening closed, and suprapubic drainage established.

(b) *Total Cystectomy.* This is indicated where multile sessile growths are present or where large areas are involved by a single growth but the surroundings of the bladder are not yet invaded.

The operation should be done in two stages.

(1) After suprapubic cystotomy has been done and the growth explored, if it be decided that cystectomy is advisable the ureters are diverted. The best place is probably the loin, since there is less risk of ascending infection in this situation than when the ureters are translated into the rectum or vagina.

The ureters are exposed by the gridiron incision already described in exploring for stone, in either iliac fossa, traced down to the bladder, cut across, and brought out through the skin, where they are fixed with sutures, and the urine drains into suitable receptacles. The bladder should be washed out with oxycyanide solution daily for a week, when it may be attacked. The suprapubic incision is enlarged, the peritoneum separated from the bladder as far as possible, then opened ; it will need opening in most instances. The bladder is dissected from its anterior and lateral attachments and then separated from the rectum, the vessels being clamped and tied as they are encountered till the organ and the prostate are free to the triangular ligament ; the urethra is then divided and the organ removed. Any enlarged glands along the internal iliac vessels are then removed, the peritoneum closed, and the muscles drawn together ; the wound is drained three days. This type of operation will probably be employed more as our technique improves.

The Trendelenberg position is essential for the larger operative attacks on the bladder.

FISTULÆ OF THE BLADDER. These may open on to the skin, into surrounding viscera (rectum and vagina), or into abscesses and cysts in the vicinity.

Surface fistulæ are mostly suprapubic and consecutive to operations, but may result from penetrating injuries such as bullet-wounds. If the urethra be patent such fistulæ will as a rule close spontaneously.

Should a suprapubic fistula persist, the urethra should be made pervious and a catheter tied in.

In the case of small fistulæ freshing the interior by scraping will suffice to effect closure where the urethra is patent, but the larger varieties must be dissected out down to the bladder-wall, the latter freshened and sutured with two rows of sutures, inverting the mucosa ; the parietes are closed and a catheter tied in.

Cysts (*e.g.* dermoids) or abscesses communicating with the bladder should be explored from the abdomen and removed or drained, which may not be an easy matter. Recto-vesical fistulæ may result from ulceration of malignant growths, in which case colostomy is indicated, to clear up the severe cystitis which results from this affection. When such fistulæ are due to injury an attempt should be made to reach the fistula through the perineum and suture the apertures in both viscera. Vesico-vaginal fistulæ are also treated by plastic operations and suturing through the vagina.

DISORDERS OF MICTURITION. These result from affections of the bladder or the urethra, and are of two main types, viz. *incontinence*, or inability to hold urine, and *retention*, or inability to pass urine.

The act of micturition is partly volitional, partly reflex ; the desire to micturate can be voluntarily inhibited up to a certain point, and may be allowed to take place later when the surroundings are suitable. Micturition in suitable places and at suitable times is the result of training in early youth and is lost in cases of mental deficiency, whether this be permanent, as in certain forms of insanity, or transient, as in delirium.

Being largely reflex, the function is upset by disease of the spinal cord, such as tabes dorsalis, and in fracture-lesions of the cord. In certain cases the call to micturate is so imperious that it cannot be resisted even by the trained sensorium, as with acute cystitis, stone, &c. Where actual disease of the bladder is present the term " irritable bladder " is employed rather than incontinence, which implies that the bladder is otherwise normal.

Reflex micturition is governed by a centre in the lumbar cord, the nerves from which pass in the sympathetic in two sets : (*a*) along the lumbar nerves and hypogastric plexus ; stimulation of these causes contraction of the sphincters of the bladder and relaxation of the detrusor urinæ, *i.e.* retention. (*b*) Along the sacral plexus and nervi erigentes ; stimulation of these causes relaxation of the sphincters and action of the detrusor, *i.e.* micturition takes place.

INCONTINENCE OF URINE. This is divided into (1) *active*, where the detrusor mechanism is over-active, and (2) *passive*, where there is paralysis of the sphincters.

The former condition leads to acts of micturition at inconvenient times and places ; the latter to constant dribbling of urine when the bladder is filled to a certain point, at which the lax sphincter gives way.

(1) Active incontinence is due to a failure on the part of the higher cerebral inhibition to control the desire for micturition, either from want of training or because the stimulus is too great. Thus it may result in

adults from severe cystitis, while worms, acid urine, calculus, are responsible in children ; and it is more likely to occur by night because of the lowered powers of the inhibitory mechanism during sleep.

This affection is usually found in young persons, and is an exaggeration or persistence of the incontinence of infants, which is usually eliminated by training before two years of age. This type is usually nocturnal (nocturnal enuresis), but may also occur by day. In addition to want of training there may be accessory causes tending to maintain the condition, such as phimosis, worms, adenoids, highly acid urine, calculus, cystitis ; it is also associated with weak mental and psychic states or definite feeble-mindedness, and may persist to adult life.

Treatment. In the first place any accessory causes should be removed, such as adenoids, phimosis, worms. No fluid should be taken after 6 P.M. and the child should be roused in the night, about an hour before the act of involuntary micturition usually takes place, till a habit of waking develops when a call to micturate comes. Tincture of belladonna, 10 to 30 minims three times a day, for six weeks or till signs of belladonna-poisoning (red, dry tongue and conjunctiva, dilated pupils, and nocturnal rambling) develop, will often have a good effect. Thyroid extract is advised by Williams. The administration of full doses of acid sodium phosphate is well reported. Instillation of silver nitrate 1 per cent. is sometimes beneficial. In females the neck of the bladder may be touched with the actual cautery. The small ulcer thus formed causes micturition to be painful and an involuntary act of micturition wakes the patient up at its commencement, and in this way a habit is set up.

Passive Incontinence. This arises in affections of the nervous system, the sphincter being paralysed either temporarily or permanently.

Temporary paralysis of the sphincter may be due to shock (*e.g.* con-cussion), epileptic fits, &c. Injury of the lumbar cord causes permanent relaxation of the sphincter and dribbling incontinence. Where the cord is injured some distance higher up all volitional impulses are cut off, and the cord after a time may begin to act reflexly, in accordance with the stimulus of the full bladder. Thus " reflex micturition " results, which is a normal reflex act occurring at intervals and to be distinguished from ordinary dribbling incontinence, where the urine continually flows away.

Where the sphincter and detrusor mechanism are both paralysed the bladder fills till it is distended to its mechanical limits and then urine flows away continually ; this condition is known as " retention with overflow " and is common in paralytic and other conditions. Disorders of micturition are often the first symptoms of nervous disease, especially in tabes and disseminated sclerosis. With tabes are found (1) bladder crises, (2) altered function.

(1) Bladder crises consist of cramp-like pain at the end of micturition, which may be repeated at frequent intervals.

(2) The mechanism of micturition is upset, so that the sphincter fails to relax and the detrusor does not contract, the result being slow micturition

and later partial retention (the bladder containing residual urine), which still later passes into complete retention with dribbling incontinence. Where difficulty of micturition is a symptom examination should be made for signs of nervous disease, such as lightning pains, failure of the pupils to react to light (Argyll Robertson pupil), loss of knee-jerks, loss of equilibrium with the eyes closed (Romberg), Charcot's joints, and other crises.

Treatment of Passive Incontinence. The bladder is emptied at intervals with careful asepsis and strychnine administered ; lavage with oxycyanide solution, &c., is indicated where cystitis is present.

Incontinence is sometimes divided into *true* and *false.* In the former there is weakness of the sphincter, in the latter retention with overflow, which is further discussed under Retention.

Other causes of incontinence are :

(1) Epispadias with deficiency of the sphincter.

(2) Great contraction of the bladder, as from tuberculosis.

(3) Impaction of a calculus or enlarged prostate wedging open the urethra, both of which are far more likely to cause retention with overflow.

(4) Operations involving the sphincters, such as dilatation of the urethra in women.

Treatment. The cause is removed if possible, *e.g.* prostate or calculus. Strychnine is given where the sphincter is over-stretched ; where the cause is irremovable a portable urinal is the only resource.

RETENTION OF URINE. This varies in degree from inability to completely empty the bladder (in which case there is said to be " residual urine " present) to complete inability to pass any urine at all. *Retention* is thus to be clearly distinguished from *anuria*, in which no urine is secreted by the kidneys. In the latter condition the bladder is empty, in the former full. The full bladder may be felt as a median, fluctuating tumour rising out of the pelvis, which is emptied by the catheter if one can be introduced or, failing that, by suprapubic puncture, with one exception, and that is where the bladder is filled with blood-clot. Moreover, the patient has an intense desire to micturate, which is quite absent with anuria. Retention may be due to (*a*) failure of the neuro-muscular mechanism or (*b*) from mechanical obstruction in the urethra.

ATONY OF THE BLADDER. When the bladder is unable to empty itself in the absence of mechanical obstruction it is said to be atonic, and gradually distends till the inability to empty is complete, the condition then being retention. This is due to the detrusor muscles gradually failing to overcome the tension of the sphincter and passage of the urethra. Where the distension is due to block of the urethra the bladder will hypertrophy at first, but when the task exceeds its powers it gives in and becomes gradually atonic till retention results. In other instances the failure is primarily in the neuro-muscular mechanism, the wall being weakened and gradually dilating, though no urethral blockage is present. Atony is a stage of retention, and in this condition residual urine is found in the bladder by passing a catheter after the patient has emptied the bladder as far as possible by his own efforts.

(a) *Neuromuscular Causes of Atony and Retention.* (1) Local disease of the bladder-wall, *e.g.* cystitis.

(2) Atony ending in retention may result from chronic nervous disease, *e.g.* tabes.

(3) Acute toxæmia, such as enteric fever and influenza.

(4) Mineral poisons, *e.g.* lead.

(5) Reflex interference, such as operations on the bladder, urethra, rectum, spermatic cord.

(6) Finally, hysteria is a recognized cause in young women.

(b) *Mechanical Causes of Atony and Retention.* Obstruction to the outflow of urine will cause retention, but not necessarily atony. Thus from spasm of the sphincter urethræ following operation for piles, &c., retention often results, or this may result from impaction of a calculus in the urethra, but if this be relieved before the bladder is greatly distended atony should not result, though if left too long before the spasm is relieved atony may ensue. In other words, where the cause is a weakness of the bladder-wall there is atony as well as retention, but a sudden block of the urethra, unless prolonged, produces only retention without atony.

Mechanical causes of atony are :

(1) A single prolonged period of obstruction to the outflow from the bladder.

(2) Increasing difficulty of forcing urine through a difficult urethra (enlarged prostate, stricture of the urethra, &c.).

Mechanical causes of retention are obstruction to the urethra in any part of its course.

(1) In the cavity of the urethra :

Impacted stones or foreign bodies.

(2) In the wall of the urethra :

Enlarged prostate, stricture (congenital and acquired), ruptured urethra, urethral abscess, spasm of the compressor urethra.

(3) Causes outside the urethra :

The pressure of fibroids, the retroverted gravid uterus, phimosis, paraphimosis, strings tied round the penis, perineal abscess, &c.

Treatment of Atony. Any block in the urethra is removed and the bladder is prevented from distending by regular catheterization and drugs which increase the tone of its wall, such as strychnine and ergot, while abdominal massage and exercises are worth a trial.

Treatment of retention depends on the cause.

(1) Where the neuromuscular mechanism is temporarily out of order, as with reflex retention after pelvic operations, &c., if not relieved by fomentations, the passage of a catheter, possibly repeated, will suffice. Where chronic nervous disease is the cause catheterization at regular intervals is indicated.

Where there is a stone or foreign body in the urethra it should be removed.

Where the cause is in the urethral wall, as stricture or enlarged prostate, the patient is placed in a hot bath and given thirty minims of tincture of

opium ; failing this, attempts are made to pass catheters, and if relief is not obtained the bladder is emptied with a fine aspirating-needle inserted just above the pubes, and later measures are taken to obviate the cause (prostatectomy, urethrotomy, &c.). Where the pressure acts outside the urethra it should be removed by slitting up a tight foreskin, reducing a paraphimosis, replacing a retroverted uterus, passing a catheter where fibroids are the cause, and later removing the uterus. Further details are given under the Surgery of the Urethra (p. 625).

AFFECTIONS OF THE PROSTATE

Anatomy. The prostate, an accessory sexual gland of the male, is situated at the outlet of the bladder, and is usually likened in size and shape to a chestnut. Like the bladder, of which it forms the apex, it is roughly a four-sided pyramid, and has two antero-lateral surfaces in relation to the levator ani, a posterior surface in relation to the rectum, through which it may be readily palpated, and an upper surface which faces the interior of the bladder. The gland is surrounded by a plexus of veins surrounded by prolongations of the pelvic fascia, by which it is anchored to the triangular ligament and back of the pubis. It is made up of unstriped muscle and glandular crypts, which open by ducts in the floor of the prostatic urethra at the sides of the verumontanum. The prostate is traversed by the first part of the urethra (posterior urethra), which is normally an inch and a half long and may be increased to three inches or more where the organ is enlarged.

The prostate is also traversed from behind forwards as far as the middle of the prostatic urethra by the ejaculatory ducts from the vasa deferentia ; the posterior portion of the gland above these ducts is known as the middle lobe, while the urethra divides the organ into lateral lobes. The floor of the prostatic urethra is elevated to form the verumontanum, on the summit of which is the sinus pocularis, the homologue of the uterus and vagina, into the sides of which open the ejaculatory ducts.

INJURIES. These are uncommon except as the results of unwise catheterization, where in attempting to reach the bladder, to relieve retention from stricture or enlarged prostate, the instrument leaves the urethra and penetrates the prostate. This accident is recognized by the instrument failing to reach the bladder and extract urine after some force has been exerted, while there will be bleeding from the urethra and deviation of the point of the instrument from the urethra (*see* Stricture, p. 618).

CALCULI IN THE PROSTATE. Stones may take origin (*a*) in the prostate itself or (*b*) pass down from the bladder and become impacted in the prostatic urethra.

(*a*) *Primary Calculi.* In the acini of the gland are found small, dark, solid "amyloid" bodies showing on section a concentric structure ; these are normal, but phosphates may be deposited round them and thus calculi be formed. These stones are usually multiple, smooth and dark, lying in cystic cavities or in small abscesses. They may result from prostatitis or calcification of tuberculous nodes of the prostate.

These stones are usually latent : the signs when present are pain at the bladder neck, frequency and difficulty of micturition, while threads and pus may be found in the deep urethra by the two-glass test.

Diagnosis. They may be seen in radiographs, felt with the finger while examining the rectum, or felt when passing sounds or cystoscopes as a gritty feeling in the deep urethra, or only detected, after suprapubic cystotomy, by palpating with the finger in the deep urethra.

(b) *Secondary stones* arising from impaction of a vesical calculus or a portion of one of these, will cause similar signs or, more likely, sudden retention of urine, and will be felt when an attempt is made to pass a silver catheter.

Treatment. When causing symptoms it is sometimes possible to remove these stones from the urethra, or if the bladder has opened above the pubes, by this route. In general, however, the most useful approach is by the perineum, the stones being removed with a scoop, and if the prostate be riddled with stones or much enlarged it should be removed as well.

INFLAMMATIONS AND INFECTIONS OF THE PROSTATE. The gonococcus is the most usual cause of both acute and chronic prostatitis ; accessory causes are hard riding (sometimes related to hard living), alcohol, constipation, and sedentary existence. Other infective organisms less often found are staphylococci, the colon bacillus, and not least the tubercle bacillus.

Acute Prostatitis. The paths of infection are : (a) *via* the urethra and urethral lymphatics, following urethritis or the use of dirty instruments ; (b) blood-borne infection, as in pyæmia and specific fevers. The usual cause is gonorrhœa assisted by the use of injections of too great strength, or riding and bicycling with a recent gonorrhœa.

Anatomy. In the milder cases there are engorgement and œdema of the gland with collections of pus in the acini. In the more severe types these minute abscesses coalesce till large abscesses result, most of the gland being destroyed. Resolution is common in the milder forms, while in the more aggravated sort the abscess may burst (a) into the urethra and cure results ; (b) on the perineum, which also heals ; or (c), fortunately rarely, into the rectum with the formation of a recto-urethral fistula.

Signs. The onset is usually sudden and in the course of a gonorrhœa. There is pain in the perineum on micturition and defæcation, frequency with pain at the end of the penis, sometimes blood at the end of micturition. Retention of urine is common. Fever is moderate : any attempt to pass instruments is most painful and should be deferred till the patient is in bed. Per rectum the prostate is enlarged, tender, and boggy ; when a well-developed abscess is present the prostate will fluctuate and the wall of the rectum feel œdematous.

Pus and threads, containing gonococci, are found in the deep urethra (two-glass test).

Diagnosis. In tubercle of the prostate the greater chronicity, hard nodules in the prostate, absence of œdema, possibly a craggy epididymis, enlarged kidney, or tubercle bacilli in the urine will distinguish.

From sarcoma of the prostate, which is rare, the absence of urethritis in the latter affection will separate, and the fact that the prostate is larger and, though elastic, is not œdematous or tender.

Treatment. The patient is kept in bed, the bowels freely opened ; hot hip-baths and fomentations to the perineum are comforting, while diuresis should be free. In most instances the abscess will burst into the urethra or be burst while passing a catheter to relieve retention of urine, which is a common complication. Where softening of the gland is felt per rectum the
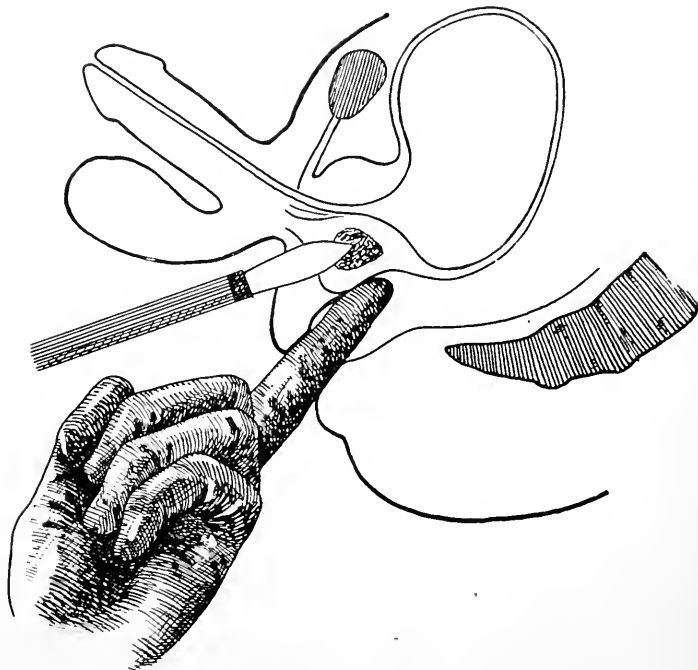
Fig. 201. Method of opening a prostatic abscess.

abscess should be opened at once to avoid any risk of a recto-urethral fistula, and this is also indicated where the abscess does not burst per urethram in a few days or where the constitutional signs are severe—rigors, &c.

The simplest plan of opening these abscesses is to place the patient in the lithotomy position and make an inch and a half incision in front of the anus, half an inch from the middle line, and then, with the left forefinger as a guide in the rectum, sinus-forceps are used to bore into the perineum and prostate till the abscess is encountered ; the opening is enlarged and the cavity explored with the right forefinger, loculi broken down and free drainage established, the tube being removed in four days : a urinary fistula often follows for a short time. Opening from the rectum is bad practice and should be avoided. After the abscess is healed the posterior urethritis will still need treating (*see* pp. 591, 612).

Chronic Prostatitis and Vesiculitis. This is a common complication of chronic posterior urethritis. The prostate seldom escapes where the

posterior urethra is infected for more than a year. The infection is usually gonorrhœal, and the accessory mild traumas are as in acute prostatitis. The acini of the gland becomes filled with pus and debris and are blocked by surrounding chronic inflammation and fibrosis. Later the acini become atrophic and the gland shrunken, hard, and fibrous.

Signs. Pain in the perineum and neck of the bladder, irritation of the tip of the penis during micturition, frequency of micturition (especially at night), and, later, atony of the bladder with partial retention may result. Frequent nocturnal emissions, sometimes tinged with blood, are not infrequent. In addition to these local signs the psychic and nervous element is often marked ; neurasthenia and a fear that their potency is lost depresses some patients, who may become irritable and even attempt suicide.

Diagnosis. The anterior urethra is washed out and the urine collected in two glasses ; the first contains pus and threads, the second is clear unless cystitis be present. In the latter case the bladder is washed out and then the prostate massaged per rectum and the prostatic contents, thus expressed, milked from the urethra. Where prostatitis is present, pus, plugs from prostatic crypts, blood, and organisms are found.

On rectal examination some general enlargement of the prostate and vesiculæ can be made out and slight tenderness.

Posterior urethritis usually accompanies this affection, while vesiculitis and epididymitis are frequent complications.

In young men the diagnosis has to be made from tuberculosis of the prostate, in old men from adenomatous enlargement, since the fibrosing shrinkage of chronic prostatitis leads to the formation of a small fibrous prostate of the " collar type," with difficulty of micturition, retention, &c. Routine examination on the above lines will serve to differentiate these conditions.

Treatment. Congestion of the prostate is avoided by abstinence from sexual intercourse, riding, cycling, and excessive exercise, while the bowels are kept freely open. General tonics, iron, strychnine, sea-air, are advisable ; sometimes iodides are beneficial.

Local Treatment. The prostate should be massaged per rectum to express its contents and the posterior urethra irrigated with dilute antiseptics. Urotropin and diuretics are administered effectually to flush the posterior urethra. The posterior urethra may be irrigated with the catheter or by Janet's method (p. 612) ; permanganate of potash 1' in 2000 to 4000 is useful for irrigation. If this plan proves ineffectual after some weeks, instillation of silver nitrate into the deep urethra in strength varying from 2 to 5 per cent., in quantities of a dram, at intervals of a week, should be tried.

The passage of the largest steel bougies is sometimes useful, especially where the condition is of old standing and some obstruction of the urethra is present. In rebellious cases of long standing it will be necessary to explore the prostate from the perineum, either removing part of the gland (prostatectomy) or incising it longitudinally and keeping the urethra dilated with bougies (linear prostatotomy). These cases are often most difficult to cure.

Suprapubic prostatectomy is not advisable in these cases as the gland is extremely adherent to its capsule and defies removal.

TUBERCULOSIS OF THE PROSTATE AND VESICULÆ. This is rarely a primary infection ; usually it spreads from the epididymis, or more rarely from the kidney along the lymphatics of the vas or ureter.

Anatomy. This resembles that of tubercle elsewhere : small grey tubercles caseating and tending to run together form caseous masses, which break down into abscesses or become calcified and surrounded with fibrous tissue or perforate into the bladder or on the perineum, forming fistulæ, in which case secondary infections are the rule.

Signs. The condition is often latent at first, attention being drawn to it when examining, as a routine measure, in cases of disease of the kidney, bladder, epididymis, or chronic posterior urethritis.

Early signs are pain on defæcation and micturition and frequency of the latter, especially at night. Blood may be noted in the urine or semen and tuberculous foci detected in the lung, kidney, or testis. Per rectum the prostate is slightly enlarged, with hard nodules scattered through its substance, though the latter are not so hard as in the case of cancer. These nodules soften later, forming cold abscesses. The disease is often unilateral, and the epididymis on the affected side is often thickened and hard. In most cases the disease is of chronic nature, tending to heal by fibrosis if the other foci in the testis or kidney are removed. The usual age is from twenty to forty-five : pus and tubercle bacilli are found in the result of prostatic massage or in the urine.

The diagnosis from gonorrhœal prostatitis is made by the better demarcation of the nodules in tuberculosis, the presence of the bacillus, and the finding of broken-down nodes in the epididymis with scars of healed fistula, which are uncommon in venereal epididymitis ; from cancer by the slighter hardness of the nodules, the presence of the bacillus, and pus in the urine. Calculi in the prostate are distinguished by their greater hardness, mobility, and the gritty sensation when a sound is passed.

Treatment. Where the primary disease is in the testis or kidney this should be removed if unilateral ; it is questionable whether both testes should be removed under these circumstances. General tonic treatment should be adopted—fresh air, good feeding, cod-liver oil, iron, &c.

Instrumentation is to be avoided and the irritability of the bladder controlled with sandal-oil, tincture of hyoscyamus, or morphia suppositories when severe. Injections of tuberculin are spoken well of by some. Where cold abscesses form they should be opened aseptically through the perineum to avoid fistulæ, through which secondary infection is certain ; they should be swabbed out with biniodide of mercury 1 in 1000 and closed without drainage.

NEW GROWTHS OF THE PROSTATE. These may be innocent or malignant.

Innocent Tumours of the Prostate ; Enlargement of the Prostate. Innocent tumours of the gland are histologically fibro-myo-adenomas, consisting of a varying amount of each constituent, some being chiefly myomas, others

principally adenomas, while less often the condition is that of fibroma, though the majority of small fibrous prostates are probably the results of chronic prostatitis and are not new growths in the strict sense at all. The majority of cases are adenomas.

The cause of these growths is unknown ; they are common in men over fifty, but in many instances no inconvenience is caused by their presence.

The trouble caused is urethral obstruction, with all the added disabilities from failure to empty the bladder, stagnation and infection of the urine, back-pressure in the kidneys, hydronephrosis, renal infection, &c.

Anatomy. (1) Where the condition is adenomatous or fibromyomatous there occur single or, more usually, multiple tumours in the substance of the gland, causing enlargement of the gland as a whole, usually more marked in one lateral lobe than the other, sometimes confined to the posterior part of the organ and then forming the " posterior median lobe." The increase in size of the gland causes it to expand towards the bladder, as it is restrained in other directions by the dense fascia covering the prostate. The gland spreads in, between the mucosa and internal sphincter of the bladder, and with the increased size of the prostate the prostatic urethra becomes longer so as to have a length of three inches or more. The adenomas are usually well encapsuled and can be readily shelled out ; the operation of enucleation of the prostate is in most instances, certainly where it is easy, an enucleation of the adenoma from the thinned-out relics of the gland, and not a removal of the gland from its proper capsule ; the thinned-out gland around an adenoma closely resembles a capsule. Microscopically the tumour consists of a fibrous capsule from which fibro-muscular trabeculæ traverse the mass, containing glandular acini between them. The latter are lined with columnar epithelium, and may be dilated into cysts containing debris and " amyloid " bodies. In some instances signs of inflammation are present in the shape of organizing fibrous tissue and infiltration with leucocytes ; rarely pure fibromyomas are found devoid of glandular elements.

(2) The small fibrous prostate is not enlarged appreciably, but is tough from formation of fibrous tissue in its substance and is firmly adherent to its capsule, enucleation being almost impossible. Microscopically the gland substance is replaced by dense fibrous tissue, the continuity of which with the fascial capsule explains the difficulty of enucleation.

Changes in the Urethra. The urethra is only narrowed in the small fibrous type ; in the adenomatous prostate narrowing of the urethra is rare, but the channel is elongated and its curve altered so that it becomes S-shaped or deviates laterally if one lateral lobe be much enlarged ; where the enlargement is of the so-called median lobe the latter hangs down into the orifice of the internal meatus, obstructing the latter like a ball-valve.

Effect on the Bladder. To overcome the difficulty of voiding urine the bladder-wall hypertrophies and becomes trabeculated, the muscular bands standing out in marked relief. When the increased power thus obtained is insufficient to expel the urine the bladder dilates and the wall gives way between the muscular trabeculæ, so that " pouching " occurs

as well as general dilatation.   The projection of the prostate into the bladder, from its overgrowth, causes a pouch to form behind the gland ; this " post-prostatic " pouch is difficult to empty and " residual urine " first collects here.   Later infection of the stagnant urine produces cystitis, and then either atony of the bladder comes on apace from affection of the muscular coat or fibrosis of the wall leads to shrinking of the bladder ; the former is much more usual and " retention " results.   Still later changes occur in the kidney—first back-pressure and hydronephrosis, then infection with pyelitis and pyonephrosis. Strain-ing to empty the bladder causes hernia and prolapse of piles.

FIG. 202.   Section of bladder, showing enlargement of the prostate, " median lobe," and a post-prostatic pouch.

Symptoms and Signs.   These vary considerably : thus if the earlier stages are latent, as is not uncommon, the first thing noted may be the supervention of an attack of acute retention, or dribbling incontinence may point to the possibility of an overfull bladder.   In such cases the con-dition is obviously of some dura-tion, and the secondary changes in bladder and kidneys render the prognosis worse.   More commonly the earliest symptom is nocturnal frequency of micturition, and when this is found in patients over fifty, adenomatous enlarge-ment of the prostate is very probable.   The frequency be-comes more marked, and diurnal as well as by night, while at the same time the stream of urine becomes diminished in power, so that the patient experiences difficulty in emptying the bladder ; nor does straining improve matters, as it does where the obstruction is due to stricture of the urethra.   After some months of this condition an attack of acute retention takes place, often immediately due to cold or alcoholic excess, while in the more feeble types of patient retention with overflow will be found.   Pain is not marked in the earlier stages, but there may be cramping pain in the perineum or neck of the bladder when the latter tries to empty itself, or later in the lumbar region when back-pressure is producing changes in the kidneys.

When secondary cystitis has arisen pain will be a marked feature.   The reason for the early frequency is not clear ; probably the enlarged prostate lying in the neck of the bladder acts as a foreign body and stimulates the expulsive mechanism, just as does a stone.   Retention is due to failure of the muscular mechanism of the bladder, aggravated by swelling of the

congested prostate from cold or excess, less often to profuse bleeding of the congested gland into the bladder with formation of clots in the latter, leading to " clot-retention." General signs only occur late, and are due to renal inadequacy from degeneration and infection ; these are thirst, loss of appetite, vomiting, a furred tongue, diminished excretion of urine,
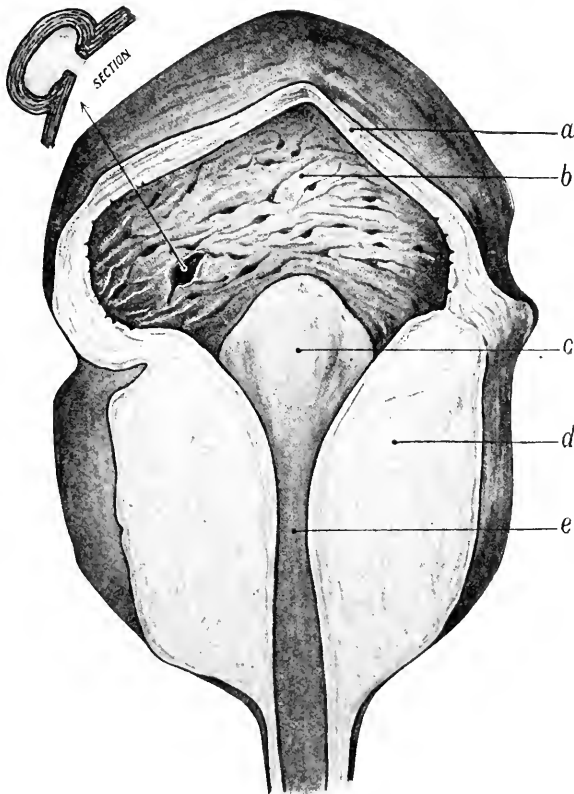
Fig. 203. Enlargement of the prostate and sacculation of the bladder. General enlargement of the former as well as a " median lobe " are seen. Hypertrophy of the muscular trabeculæ of the bladder-wall and a saccular protrusion of the mucosa are evident. *a*, Bladder-wall (hypertrophied). *b*, trabeculæ. *c*, "Median lobe." *d*, Prostate in section. *e*, Urethra.

high blood-pressure, and later a fall in blood-pressure, pyuria, intermittent fever, and sweats.

Signs. Abdominal examination will reveal a distension of the bladder where a notable degree of partial retention or complete retention is present. Rectal examination should be made after the bladder is emptied : a patulous anal sphincter will suggest nervous disease rather than enlargement of the prostate. The prostate and vesiculæ are palpated, the size of the posterior surface of the prostate being noted and its consistency, whether smooth and elastic or containing hard nodules of cancer. Where, however, there is an adenomatous enlargement of the so-called median lobe the enlargement of the prostate as felt per rectum may be minimal or absent. **Bimanual**

rectal and abdominal examination will assist in disclosing residual urine, and if the bladder be empty enlargement of the prostate. Catheters should not be passed for the first time till the patient has been placed in bed, and never in the consulting-room or out-patient department; neglect of this rule accounts for many deaths. After a short course of urotropin, examination with a catheter will detect the presence of residual urine, while the cystoscope will show signs of back-pressure in the shape of pouches, trabeculæ, and stones, or a median posterior lobe. Finally, attention should be paid to the renal function as regards the specific gravity of the urine and its daily quantity, amount of urea, and the indigo-carmine test, as well as the general condition of the patient from this point of view (*see* Renal Function, p. 505).

Diagnosis. (*a*) From other causes of urethral obstruction, viz. stricture, stone, nervous disease.

(1) In stricture cases the age is much younger as a rule, though old men also may have strictures alone or in addition to enlargement of the prostate. Straining assists the passage of urine through a stricture but in prostatic obstruction renders the flow less. Enlargement of the prostate is generally felt per rectum, but not all cases of prostatic enlargement show this sign. Catheters and bougies passed with the precautions detailed will give useful evidence : a soft instrument of 10 English scale will as a rule pass readily in prostatic cases but not in cases of stricture severe enough to produce symptoms, while in the latter case the place where the instrument stops can be felt with a finger on the perineum and small bougies passed into the stricture will be gripped. The urethroscope may be of assistance in detecting a stricture.

(2) Stone in the urethra is detected by the grating felt if a silver instrument be passed down to its situation, and may be seen with the urethroscope. Impaction of a stone is usual in the membranous urethra in children, but may lodge in the prostate of adults (*see* Prostatic Calculi, p. 588).

(3) Nervous disease causing retention is found in younger persons, and due to tabes, disseminated sclerosis, myelitis, &c. ; hence the importance of examining the nervous system if the signs are equivocal.

(*b*) From other causes of enlargement of the prostate.

In young men tubercle and sarcoma are found ; the age of these patients practically excluded adenomatous enlargement : tubercle is further distinguished by the nodular feel of the prostate, other nodules in the epididymis and tubercle bacilli in the urine, while sarcoma is distinguished by the huge size of the prostate.

Carcinoma occurs from forty onwards and fairly often in adenomatous prostates ; it is distinguished by its stony hardness, which may be general or in nodules, and by the gritty grip which is experienced in passing a cystoscope or large sound through the deep urethra, and later by feeling per rectum its extension to the bladder and fascial connexions. Secondary deposits in bones are not infrequent from cancer of the prostate and may assist in the diagnosis of doubtful cases.

Treatment. (*a*) *General.* A warm, dry climate, avoiding chills by suitable clothing and obviating pelvic congestion by careful regulation of the lower bowel, is advisable. Diuretic waters, light wines, and plenty of plain water will assist in maintaining renal function, and where infection of the urinary tract is present or likely to ensue urotropin (grs. 5) and acid phosphate of soda (grs. 30) should be given thrice daily. The patient reaches the danger zone the moment any instrument enters the bladder, and we must consider how this is best done and when instrumentation is unnecessary.

(*b*) *Local Measures.* Where the symptoms are only frequency and slight difficulty of micturition, the bladder not being obviously distended, as shown by bimanual examination, no catheter is passed but the patient given drugs to increase the tone of the bladder, such as strychnine and ergot combined with saline diuretics and tincture of hyoscyamus. Where this fails to relieve after a few months a catheter is passed, with all precautions, after the bladder has been emptied voluntarily and the amount of " residual urine " estimated. If less than three ounces is found in the bladder the above regime may be continued, but if the amount of residual urine be greater there are two alternatives, (*a*) repeated emptying of the bladder by catheter (catheter-life) or (*b*) removal of the obstructing prostate (prostatectomy).

Where retention is actually present, with or without overflow, the condition is urgent ; nevertheless the catheter must not be hastily plunged into the bladder. Where the patient is otherwise in good condition, the bladder distended and painful, he is placed in a hot bath and given thirty minims of tincture of opium, which will often relieve the retention. Where no urine is passed under this treatment a catheter is passed, the patient having been placed in bed and made warm and comfortable. With all aseptic precautions a soft rubber or coudé, gum-elastic catheter will as a rule pass easily ; failing this, a silver prostatic catheter with a large wide curve can hardly fail, but should difficulty arise, rather than risk the formation of a " false passage " the practitioner should desist and aspirate the bladder above the pubis with a fine needle. When the catheter is passed successfully only about sixteen ounces of urine should be drawn off, the patient should be given diuretics and urotropin, and sixteen ounces are drawn off every four hours till the bladder is empty ; in this way shock and renal congestion will be avoided. Where the catheter passes but no urine is passed and perhaps clot is found in the eye of the instrument, or where suprapubic aspiration fails, the bladder is almost certainly full of blood-clot (" clot retention"), and should be opened above the pubes (cystostomy) and drained, a few days after which, if the conditions are favourable, the prostate may be removed.

After an attack of retention has passed off micturition may become nearly normal again and expectant measures may be adopted, though in most cases prostatectomy will be the wiser course, and where the retention persists there remains only the choice between catheter-life and prostatectomy.

Where the patient with retention is in bad condition, with thirst, anorexia, headache, vomiting, and the bladder is atonic and flaccid, or if there be dribbling incontinence, the outlook is grave, and sudden withdrawal of urine is followed by death in a few days. By administering plenty of fluid with urotropin and drawing off small quantities of urine—say ten ounces every four hours—the condition may improve and the patient recover sufficiently to stand operation, but more often it will be necessary to be content with permanent suprapubic drainage.

CATHETER-LIFE OR PROSTATECTOMY. Operation affords the only prospect of cure, and should be advised where the patient's condition is good, even in early cases, and where the effect of blocking by the prostate is small, since the mortality is far lower when the resistance of the patient is not depressed by secondary changes in the kidney due to back-pressure and infection. There is, however, no great hurry in the early cases ; they may be watched for some months before operation is strongly urged, and it should be pointed out that once begun, catheter-life goes on to the end, and though life may be prolonged even for years under this regime, the catheter will always be needed and is itself a source of danger, while the longer operation is put off the more dangerous it becomes. Catheter-life is advisable where the general condition is poor either from general disease of heart or lung, such as render anæsthetics or other operations dangerous, or where the renal function is much impaired, the urine of low specific gravity, thirst notable, and appetite bad. By employing nerve-blocking, as by the intraspinal method, with stovain, the operation is quite feasible in cases where a general anæsthetic might prove dangerous ; thus in a patient suffering from complete heart-block with a pulse-rate of 35 we have removed the prostate under stovain without any shock or alteration of the pulse.

The mortality of first catheterization is very high ; 8 per cent. die within a month (Watson). Except in patients who are nearly moribund, or of the better class who can pay attention to asepsis in catheterization, and do not wish immediate operation, the latter is advisable when the diagnosis is well assured.

Other indications are the presence of vesical calculi as well, or if bleeding occurs or repeated attacks of retention and where the passage of a catheter is difficult or very painful.

Catheter-life. At the initial attempts the catheter is passed as advised above, the patient remaining in bed for twenty-four hours after : later it is passed at bedtime where the residual urine is not more than four ounces ; where the amount is about eight ounces the instrument is passed night and morning, and where retention is complete it will have to be passed more often, and few will endure the endless trouble of this but will consent to operation. The patient must be thoroughly instructed in aseptic technique as regards hands, penis, and catheter. Convenient methods of sterilizing and carrying catheters and lubricants are to be had from instrument-makers.

OPERATIONS FOR PROSTATIC OBSTRUCTION. The enlarged prostate may be attacked through the bladder by the suprapubic route or *via* the peri-

neum ; the former is the method most in vogue at present and gives the best results for adenomas : the small fibrous prostates are better attacked through the perineum.

SUPRAPUBIC ENUCLEATION OF PROSTATIC ADENOMAS. The operation consists of two stages : (1) opening the bladder, (2) enucleating the prostate
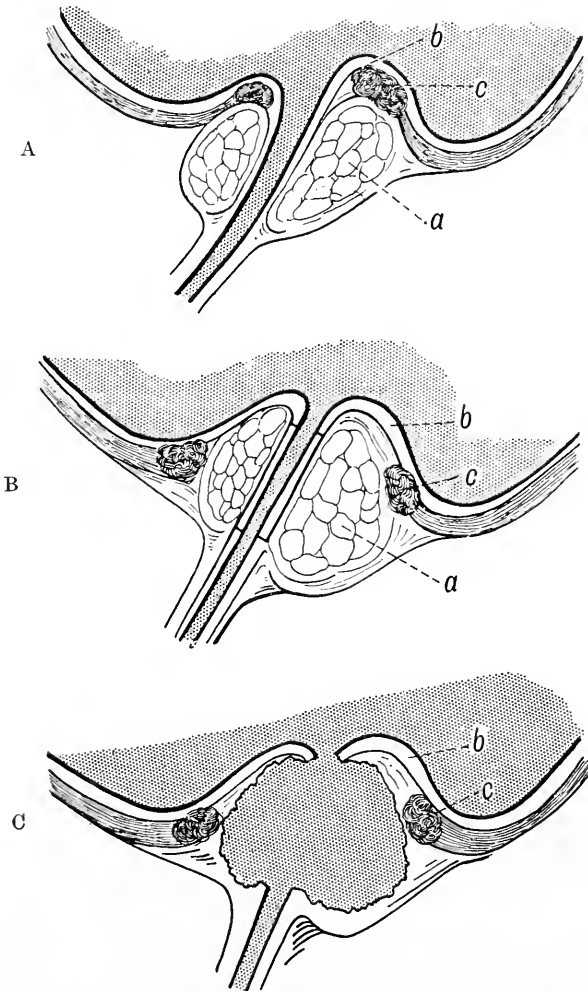
FIG. 204. A, Section of normal prostate, showing relation of the bladder sphincter. *a*, Prostate. *b*, Mucosa over prostate. *c*, Sphincter. B, Section of enlarged prostate, showing its protrusion into the bladder and relation to sphincter (letters as in last figure). C, Diagram of enucleation of the prostate.

or adenoma ; as a rule the two stages are combined in one operation, but where there has been retention, unrelievable by catheter or due to the bladder being filled with clot (" clot retention "), or where cystitis is severe, it is often better to open the bladder above the pubes, draining and irrigating it for a few days before enucleation is performed, thus giving the patient a chance of recovering his renal function and minimising the risk of infection.

The patient is anæsthetized by the injection of ·6 c.c. stovain (Billon) into the spinal theca to diminish shock and lessen the rigidity of the abdominal wall, and is placed in the Trendelenberg position. The bladder is emptied with catheter and refilled with ten ounces of oxycyanide solution 1 in 4000. The pubic region is shaved and painted with iodine and the abdomen opened by a three-inch paramedial incision immediately above the pubis. The recti are separated, the pre-vesical fat opened, and the peritoneum pushed up out of the way. The bladder, recognized by its interlacing muscular coat, is fixed with two sling sutures and opened between these by an inch-and-a-half incision, the interior explored, and any stones found are removed. Next two fingers of one gloved hand are inserted into the rectum and the prostate caught between these and two fingers inside
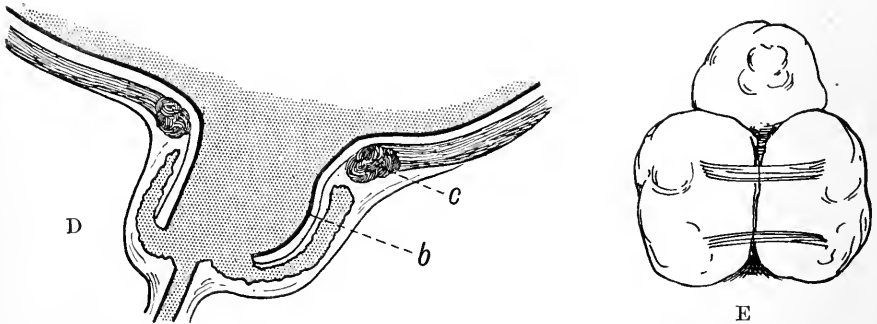
Fig. 204A. D, Enucleation of the prostate, showing how mucous flaps cover the raw surface. E, Adenomatous prostate after suprapubic enucleation.

the bladder. The enucleation commences by tearing through the mucosa over the prostate close to the internal urethral meatus, and the mucosa is then stripped off the tumour with the outer layer of the prostate. Whether this is thinned-out gland or capsule is immaterial; there may be some difficulty in finding the correct plane of cleavage, but once found, enucleation proceeds rapidly, the fingers being worked round the prostate or adenoma from the internal meatus to the apex, at which point the urethra is torn through, as it is impossible to preserve much of the prostatic urethra. In addition the ejaculatory ducts are torn across, but this is of no consequence. The prostate or mass of an adenoma is then removed from the bladder and the cavity remaining irrigated with a few pints of hot lotion to check bleeding. A wide tube is placed into the bladder, which is partially closed with catgut. The rectus-sheath and skin are closed, and Irvine's suprapubic tortoise dressing may be fitted on at once to receive the drainage from the bladder and keep the patient dry.

The lower end of the flap of bladder-mucosa thus bluntly dissected of the prostate falls into the cavity left by removing the prostate and unites with the upper end of the urethra.

After-treatment consists in minimizing shock and promoting diuresis by giving plenty of bland fluid by mouth or subcutaneously. The bladder

is irrigated daily by the suprapubic tube to remove clots, which if left are a fertile source of stones. After five days the tube is removed and irrigation carried out through the suprapubic fistula as long as it is sufficiently patent. Urine will commence to pass by the urethra in ten to twenty days (we have found it pass this way as early as the fifth day), and if delayed longer than this time it is well to pass catheters by the urethra and to irrigate through these, as occasionally strictures form at the junction of the urethra with the vesical mucosa.

Complications. Hæmorrhage can usually be controlled by hot irrigation and hypodermic injections of ergot ; where these measures fail the wound should be reopened and a Ferguson's speculum inserted, forceps placed on any bleeding-point and left there twenty-four hours, or if no bleeding-point can be found the cavity is packed with gauze steeped in adrenalin.

Uræmia, as indicated by diminution or suppression of urine, vomiting, anorexia, &c., is treated by administration of copious fluid by mouth and infusion of saline solution into the rectum or veins.

Infection is guarded against by diuretics, urotropin, and acid sodium phosphate, but in spite of all care a certain number of cases will succumb to this. Pulmonary embolism following thrombosis of the iliac veins suggests the need for the patient's remaining in bed at least three weeks.

PERINEAL PROSTATECTOMY. This is not often indicated, and only where the prostate is of the small, hard type which clings closely to the fascial sheath and can only be enucleated with difficulty. The prostate is exposed by a transverse incision in the perineum (the patient being in the lithotomy position), the transverse perineal muscles are separated from the sphincter-ani, and the back of the prostate is exposed by pushing back the rectum. The membranous urethra is opened on a staff above the triangular ligament at the apex of the prostate, and with a suitable tractor (Young's is useful) inserted through this aperture the prostate is pulled down. Lateral incisions are made into the gland on either side of the middle line (to avoid the ejaculatory ducts) and the gland enucleated piece-meal through these by blunt dissection, the urethra being preserved as far as possible, as well as the vesical mucosa over the gland. When all the gland has been removed the wound is closed, the bladder being drained and irrigated by a tube through the aperture in the membranous urethra.

Relative Merits of the Two Routes. The suprapubic route possesses nearly all the advantages, being quicker and more complete in the case of genuine adenomas, which form the bulk of instances, and the bladder can be better examined for stone or growth by the upper route. Incontinence of urine may occur from injury to the compressor-urethræ muscle in the perineal operation, never after the suprapubic route. Injury to the ejaculatory ducts is less likely in the perineal route, but this is of slight moment. The mortality is much the same by either route. Where, therefore, the prostate is large and succulent the suprapubic route is advised, but where the gland is small, hard and fibrous, and will probably be extremely difficult to remove by the upper route, that below the pubis is advisable.

Castration and *vasectomy* as treatment for enlargement of the prostate (from their effect of sometimes causing reduction in its size) have passed into well-merited oblivion.

In a few instances, where prostatectomy is out of the question from the patient's condition and catheterization is impossible, a permanent suprapubic fistula is established by passing a large trochar and cannula into the bladder above the pubis and introducing a catheter through the latter : the catheter is retained permanently and drains into a portable urinal.

Of *malignant growths*, cancer and sarcoma are found.

CANCER OF THE PROSTATE. This is more common than was formerly supposed, something like one-fifth of the cases of enlargement of the prostate being due to this disease. It occurs at the same age as adenoma, 50 per cent. of the cases being between fifty and sixty (Young), while over sixty it is relatively common. The disease is associated with adenoma in about half the instances, but affects a different part of the gland, being posterior and below the urethra, while adenoma is median and central in position (Young), and according to this observer cancer does not start in an adenoma but alongside of and later invades the latter.

Anatomy. The growth is usually of hard, scirrhus type containing much fibrous tissue, but may be of the more cellular and rapidly growing variety. The growth spreads locally into the capsule of the gland, and so to the pelvic connective tissue and wall of the bladder and rectum. General dissemination by blood and lymph channels is common, so that secondary deposits in lungs or bones, while the primary is but a small nodule in the interior of the gland, explains some obscure cases of spontaneous fracture. The lumbar and iliac glands are often extensively affected early in the course of the disease.

Symptoms. The local disease may be for some time latent, and the first thing noted may be secondary deposits in bones or the lumbar glands, or the condition may arise in an adenomatous gland, the patient having had signs of prostatism for some while. More often the symptoms arise in a normal gland, being similar to those caused by adenoma but advancing more rapidly : 40 per cent. die within seven months (Hotz).

Frequency at night, difficulty of micturition, and pain referred to the hypogastrium are common : hæmaturia is not often found, since ulceration of the bladder is rare.

Signs. Examination per rectum reveals one or more nodules of stony hardness in the gland with general enlargement of the latter, while later there will be fixity of the organ from invasion of the pelvic fascia and obliteration of the groove between the vesiculæ. If a sound or cystoscope be passed a grating sensation is experienced as the deep urethra is passed and the passage is not easy. In the abdomen enlarged iliac and lumbar glands or nodes on bones may be felt where the spread is advanced. The course is usually a year but may be as much as three or more, death resulting from back-pressure on the kidneys, infection from instrumentation, or general metastases.

Diagnosis. From adenoma the hardness and irregularity will distinguish, but it should be borne in mind that cancer often starts in adenomatous prostates. The tuberculous prostate is uncommon after forty, and in this affection the nodules are multiple, less hard, and better defined, while there are signs elsewhere in kidney, testis, or bladder, with pus and bacilli in the urine and frequency of micturition.

Calculi in the prostate are multiple and may grate on palpation or on passing a sound, while they are often visible on radiographic examination.

Cancer of the bladder is distinguished by the presence of pyuria and hæmaturia and by feeling a mass per rectum, above the prostate.

Vesical calculus is distinguished by the cystoscope and radiographs.

Treatment. Radical cure by removal of the organ should be attempted where the mass is movable and there are no secondaries in iliac or lumbar glands, lungs, or bone, and no involvement of the sacral nerves, where the general condition is good, and finally, where the trigone and vesiculæ are not much involved. Young's method is performed by the perineal route through a V-shaped incision, the apex forwards and situated at the bulb of the urethra. The membranous urethra is exposed, opened, and a tractor inserted ; the prostate is pulled down and freed in front by cutting through the puboprostatic ligaments ; the organ is freed at the side and behind from the rectum. The bladder is opened in front just above the prostate and the trigone cut across in front of the ureters ; the prostate is thus removed and the aperture in the bladder reduced with sutures and secured to the end of the urethra ; the perineal wound is closed and drained for a few days. Freyer reports good results in some instances after removal of cancerous prostates by the suprapubic route. Where such radical measures are not advisable the condition may be palliated as regards retention and cystitis by adopting the catheter-life and lavage, which may solve the problem till death ensues ; where, however, the passage of catheters is difficult from pain, bleeding, cystitis, &c., it will be better to establish permanent suprapubic drainage with a portable urinal, and the aperture may be used for lavage. In some instances relief may be obtained by bringing out the ureters in the loin as for cancer of the bladder and thus diverting the stream of urine from the bladder.

SARCOMA OF THE PROSTATE. This is found in young men and is evidenced by dysuria, while on rectal examination an enormous prostate is found filling most of the pelvis. No operative measures are likely to be of avail as the recurrence will grow through the operation-wound before the latter is closed. Palliative treatment, by catheter, suprapubic drainage, or ureterostomy, alone seems indicated in most instances, though a trial of Coley's fluid, heavy doses of X-rays, and radium will probably be attempted.

AFFECTIONS OF THE MALE URETHRA

Anatomy. The urethra is divided into three parts : the first, or posterior urethra, which traverses the prostate, lying above the triangular ligament, has already been described with the prostate. Of the remaining parts,

the muscular or membranous, in length half an inch, lies between the layers of the triangular ligament, surrounded by the compressor-urethræ muscle, having on either side the gland of Cowper. The penile portion, or anterior urethra, follows next and is six inches long, lying in the erectile corpus spongiosum. At its dilated commencement (the bulb) it is surrounded below and at the sides by the ejaculator-urinæ muscle, and into this part open the ducts of Cowper's glands.

The urethra is narrowest at the meatus (eight millimetres) and again at the membranous portion (ten millimetres), and is widest in the prostatic part (fifteen millimetres).

Examination. The urethra can be palpated externally from the meatus to the bulb, and in this way extravasation of blood or urine (from injury) or abscesses and the thickening of some strictures can be appreciated, while fistulous openings of the perineal or peno-scrotal parts are obvious.

The prostatic urethra can be examined per rectum as described elsewhere, by palpation, and its excretion obtained for examination by prostatic massage. The interior of the urethra can be tested as regards size with bougies and inspected with the urethroscope. This instrument consists of tubular specula of various sizes introduced into the urethra, down which light is reflected from an external source or obtained by a tiny lamp inside the tube of the speculum. Inflation with air is often useful as with the sigmoidoscope. With the help of this instrument not only can strictures be seen, but local applications can be made to granular patches, suppurating lacunæ may be opened, or warts removed.

CONGENITAL DEFECTS. These may be (*a*) stenoses and valves, (*b*) imperfect closure of the urethra (hypospadias and rarely epispadias).

(*a*) *Congenital Stenoses and Valves of the Urethra.* The urethra may be constricted at any point of its course and may even be completely occluded. Where the obstruction is of severe degree the pressure of the urine dilates the bladder, ureters and renal pelves, causing double hydronephrosis and such destruction of renal tissue that life is seldom prolonged many days after birth.

The commonest place for stenosis is at the meatus, which may be only large enough to admit the finest probe (" pinhole meatus "). In less common cases there is a valvular projection of the urethral mucosa which prevents egress of urine while possibly admitting the introduction of a catheter (Fig. 184, I). A " pinhole meatus " is often associated with minor degrees of hypospadias and is an indication of the possibility of other abnormalities, such as a single kidney. A pinhole meatus is enlarged by slitting it up and maintaining the increased size by passage of bougies twice a week for several months.

(*b*) *Failure of the Urogenital Cleft to close.* When the failure is on the upper surface of the penis the condition is known as *epispadias*, when the lower part is deficient as *hypospadias*. Epispadias is uncommon, and when complete is associated with ectopia vesicæ, or failure of the lateral walls of the fœtal body to close round the allantois in its intrasomatic or

vesical portion : the penis is rudimentary, and the condition is only a minor part of the ectopia, to which the reader is referred for treatment (p. 560). In the incomplete form the condition is stated by Morris to be a variety of hypospadias in which the penis has become twisted so that the ventral and dorsal surfaces are transposed : this is not easy to follow. The treatment is similar to that for hypospadias.

HYPOSPADIAS. In this condition there is a failure in the closing of the urogenital cleft, so that the floor of the urethra remains open for a varying part of its extent. Three main types are described, according to the extent of the deficiency :

(1) *Glandular Hypospadias.* In this condition the urethra is normal as far forward as the glans penis, just behind which it opens on the under-surface of the penis, often by a " pinhole meatus."

(2) *Penile Hypospadias.* Here the scrotum is normal, the urethra opening on the lower surface of the penis in the region of the peno-scrotal angle.

(3) *Perineal Hypospadias.* The scrotum is bifid in this affection, the testes usually undescended and imperfectly developed, while the urethra opens far back on the perineum.

In all forms of hypospadias the prepuce is voluminous, forming a hood over the end of the penis. In the two first varieties the penis may be fairly developed, though often bent down towards the perineum and more or less fixed in this position. In the perineal variety the penis is always poorly formed and much bent and bound down to the perineum. In these cases the sex may be mistaken (this is one form of the so-called hermaphrodite), the split scrotum being taken for labia, the small penis for the clitoris. The absence of vagina and uterus, as noted on rectal examination, will usually prevent such a mistake occurring, though a very small uterus may be missed ; when in doubt these cases should be regarded as males.

Treatment. In the minor glandular forms little inconvenience is experienced unless the meatus is small, when it is enlarged as described above. Where, however, the meatus is far back near the scrotum or in the perineum, besides the inconvenience for a male of micturating in the sitting posture, the penis will later be useless for sexual purposes, so that it is necessary to restore or reform the urethra to the end of the penis, besides freeing the latter from the adhesions binding it to the perineum, so that it may be able to assume the erect position.

Operation. The redundant prepuce may be employed to form the anterior part of the new urethra. A flap of this is turned over from the dorsum and brought through a slit puncture in the glans and out at the meatus, to which it is joined, after freeing the latter. This flap may suffice in the glandular and minor penile cases, but the preputial flap will not be long enough to reach as far back as a perineal meatus. In such cases a long flap may be turned forwards from the perineum behind the meatus and made to join the preputial flap. The scrotum furnishes side flaps, to cover in the original flaps, which are thus buried. Suprapubic drainage

should be maintained for fourteen days till the new urethra is well healed. This plan is a combination of Mayo's and Bucknall's methods (Fig. 205).

INJURIES OF THE URETHRA. The urethra may be injured by ill-directed attempts on the part of the surgeon to pass small catheters on cases suffering from stricture or from the patient introducing such things as pipe-stems or wires, either with a desire to promote a flow of urine, or from folly, or insanity. Such injuries are punctured wounds of the urethral wall, and are known as "false passages" (*see* p. 618). More complete injuries result from falls astride some narrow object, such as the top of a gate, or are found associated with fractures of the pelvis or other crushing violence, *e.g.* the bite of a horse.

Crushing of the urethra may lead merely to bruising or to a more or less complete division of the tube, and occurs in different parts of the urethra, according to the variety of accident responsible.

Anatomy. (1) When associated with fractures of the pelvis the seat of rupture is at the junction of the prostatic with the membranous part, *i.e.* above the triangular ligament; or, in other words, there is a separation of the prostate and bladder from the triangular ligament. In this condition urine and blood become extravasated above the triangular ligament, which prevents their passing into the perineum, and the effusion travels up at the front and sides of the bladder, in the loose, fatty tissue there situated.

(2) In the variety due to falls astride, as the urethra is jammed between the lower edge of the pubic symphysis and the object on which the patient falls, the injury happens at the junction of the bulb with the membranous urethra or in the bulb itself. Since the injury is below the triangular ligament, the blood and urine are extravasated into the perineum, where they form a notable swelling, and, owing to the attachment of the fascia of Colles to the back of the triangular ligament, they are conducted forwards into the scrotum beneath the dartos and up on to the lower abdomen beneath Scarpa's fascia, as is fully described in all works on anatomy (Fig. 206).

Signs and Diagnosis. (1) In the intrapelvic variety the patient will have suffered from a severe injury to the pelvis which may be obviously fractured. Either during a routine investigation of the bladder (which is proper in such cases) or because the patient is unable to micturate, it will be found that a catheter will not pass into the bladder, or on being apparently introduced (really passing into the prevesical space) the product is blood-stained urine. It may not be easy to distinguish such cases from those of extra-peritoneal rupture of the bladder, but in the condition under discussion the bladder is likely to be distended and palpable above the pubes as a rounded tumour, in addition to the irregular swelling at its sides due to extravasation. Injecting saline solution per urethram and measuring the amount returned may help, and the next step is to explore the bladder by suprapubic incision, when there will be found a considerable extravasation in the prevesical tissues, and if any doubt remains the bladder may be opened outside the peritoneum, when its interior will be found intact; this will do no harm, as suprapubic drainage will be needed later (*see* p. 562).

(2) In the more common "perineal" form of rupture the signs are
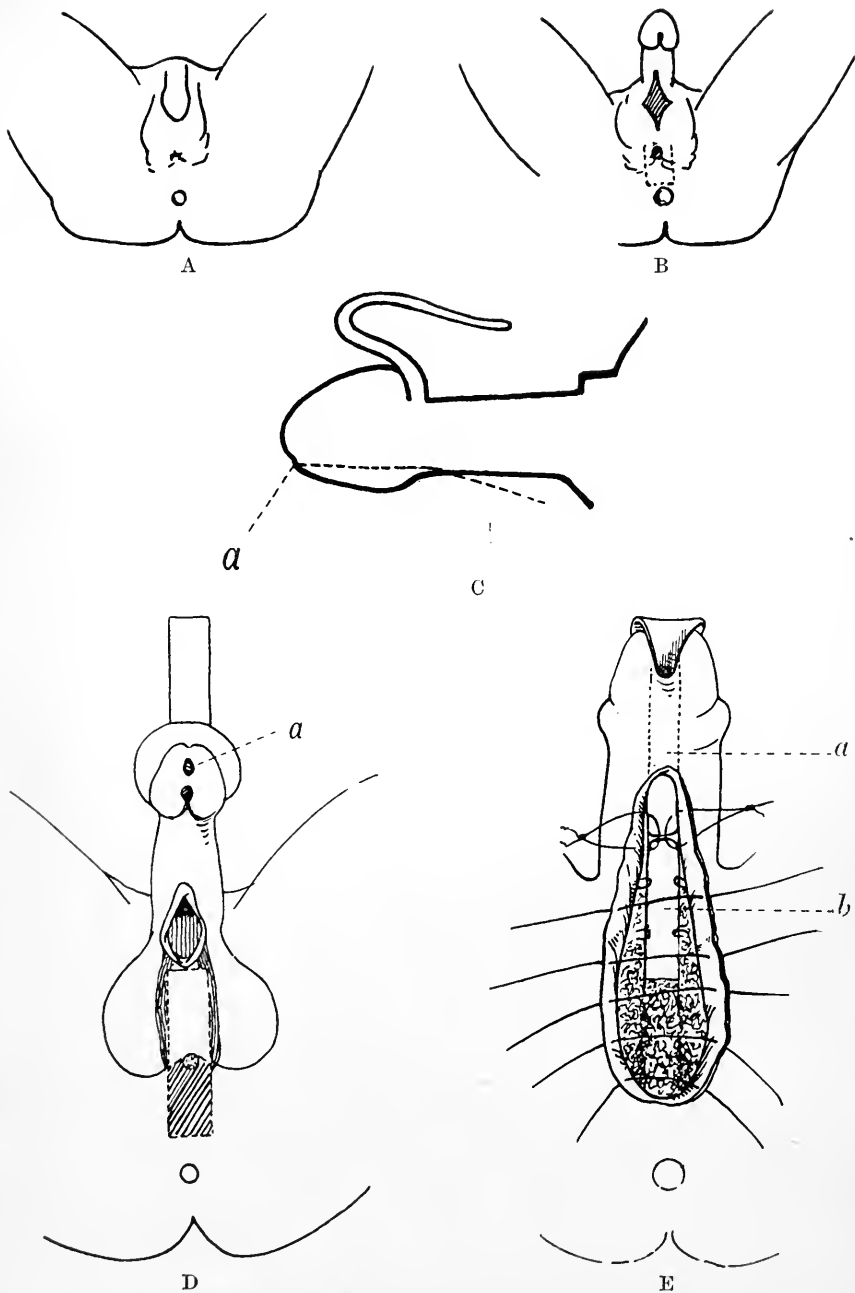
FIG. 205. Operation for perineal hypospadias. A, Hypospadias before operation. B, Penis dissected up, leaving raw area beneath it; dotted line shows the perineal flap. C, A flap of prepuce and dorsal skin of the penis to join the anterior urethra by inserting through the glans in the line *a*. D, Perineal flap dissected up to form the posterior urethra, sutured in place; the preputial flap is also seen and the aperture in the glans through which it is pulled. E, Preputial flap in place is being sewn to the perineal flap or tube, while the skin of penis and scrotum is being sutured over all; *a*, preputial portion; *b*, perineal portion of the new urethra.

more obvious : there is a history of injury in this region and the patient is unable to micturate ; nor should he be encouraged to do so, as this will only increase the amount of extravasation.   On examination there will be found bruising and swelling in the perineum about the bulb, which at first consists of blood but later of urine as well, as the patient succeeds in passing urine through the torn urethra into the perineal tissues. This swelling will spread as described, to the scrotum, penis and lower abdomen, till these are huge and black with œdema and ecchymosis (Fig. 206 II, Fig. 207). In some cases there will be free bleeding from the urethra quite apart from acts of micturition, proving that the source of blood is in the urethra.   On attempting to pass a catheter difficulty will be experienced in the region of the bulb and its passage may prove impossible.

Fig. 206. Diagram to show extravasation of urine and blood from rupture of the urethra.   I, Rupture of urethra above triangular ligament. II, Rupture of urethra below triangular ligament.

(3) In the rare cases of rupture of the penile urethra, bleeding from the meatus apart from micturition, swelling and bruising of the penis at the site of injury, and difficulty in passing a catheter will make the diagnosis.   In obscure cases the urethroscope may be of assistance.

Treatment. (1) Where the urethra is torn inside the pelvis it will be difficult to suture from the perineum, and possibly the bladder will have been opened in exploring for rupture of the bladder. This will be of assistance, for the patient is then placed in the lithotomy position and the urethra explored from the perineum as in the next variety, passing a staff as far as the urethra allows.   The proximal aperture of the urethra is found by passing a catheter from inside the bladder along the prostatic urethra and so along the penile portion.   The ends should be approximated with sutures as far as possible, but accurate apposition is less easy in this situation than in the next.   Where there is great shock from fractured pelvis, &c., it may be well to content oneself with draining the bladder above the pubes

and trying to re-form the urethra after some days, when the patient's condition is less grave.

(2) In the usual type of case where the injury is at the bulb, treatment varies with the degree of injury. Where there is hæmorrhage from the urethra and inability to micturate, but no swelling in the perineum along the course of the urethra and a catheter can be passed, there is probably only some laceration of the mucous lining, and it will suffice to tie the catheter *in situ* for five days, keeping the patient in bed and later passing bougies at intervals to make sure that no stricture results. Where there is, however, a marked swelling at some point along the urethra, whether a catheter can be passed or not, it is wiser to explore the urethra through the perineum. The patient being in the lithotomy position, a staff (Wheelhouse's is a useful type) is passed down to the site of rupture and the infiltrated tissues freely divided in the middle line, clearly exposing the distal part of the urethra. If the rupture be complete there may be some difficulty in finding the proximal end, but usually some shreds of mucosa will remain, joining the two portions, and give a useful clue.

FIG. 207. Rupture of the urethra in the perineum, showing penis and scrotum black and distended with blood and urine, which is spreading into the lower abdomen.

Otherwise the upper part is found by patient search and by remembering that the urethra appears white when the wound is sponged clean of blood, which is very essential in this operation. Where this method fails the bladder is opened above the pubis and a catheter passed in a reverse direction down from the bladder to show the orifice. Having identified the proximal part, a soft catheter (8 to 10) is passed the whole length of the urethra into the bladder, badly crushed portions of urethra cut away, and the freshened ends carefully sutured together with fine, plain catgut round the catheter; good apposition is essential. The superficial wound is closed in layers and the catheter retained from eight to ten days. Where the operation is done early before much extravasation has occurred the wound will heal well, usually by practically first intention. Care is needed to keep the patient under observation and pass bougies

at intervals for a year or more to make quite certain that stricture does not follow.

Some surgeons drain the bladder above the pubis after suturing the urethra, but as this does not prevent a little urine trickling down the urethra, and as the results of suturing over a catheter are so good, we do not advise this complication. When the patient only appears late with gross extravasation in the perineum and abdomen which is infective and causing spreading cellulitis, suture of the urethra is out of the question ; free incisions are made in the perineum down to the laceration and the bladder drained by a tube ; incisions in the scrotum and lower abdomen may also be needed. At first free drainage is all that can be done, but when the inflammation subsides attempts are made to reconstruct the urethra, either by introducing and retaining a catheter for some days or by exposing the urethra, freshening the ends, and suturing over a catheter.

(3) Penile lacerations may usually be treated by tying in a catheter, if one can be passed, but where this fails the urethra must be explored and sutured as before ; there is some risk of a penile, urinary fistula forming after such an accident.

IMPACTION OF FOREIGN BODIES IN THE URETHRA. Small stones may pass out of the bladder and become impacted in the urethra ; this occurs usually in children at the membranous part and at the meatus : allusion has been made already to impaction in the prostatic urethra of adults.

Signs. There arises a sudden attack of retention of urine with pain in the penis, and possibly a previous history of renal colic is obtained. The diagnosis is made by attempting to pass a metal catheter, which gives a click as it touches the stone.

Treatment. When in the meatus the latter should be slit up to permit of extraction. When impacted in the membranous part, if the stone cannot readily be pushed back with a sound and removed after crushing, it should be exposed by incision in the perineum and so removed.

Foreign bodies introduced by the surgeon or patient are bits of catheter, pencils, pins, pipe-stems, &c. They cause obstruction to the passage or complete retention of urine, and later ulceration, abscess-formation, and even extravasation. Most of these objects can be extracted with suitable forceps or with a lithotrite ; failing this, through a perineal incision. Large-headed pins introduced head first can be reversed by pushing the point through the urethral wall and penis, then taking hold of the point and pushing the pin head first to the meatus.

INFLAMMATIONS OF THE URETHRA. These are due to microbic infection, in some instances aggravated or initiated by the presence of foreign bodies in the urethra or by the passage of highly acid urine in gouty subjects. The most important organism is, of course, the gonococcus, which is responsible for most cases of urethritis, but pyogenic cocci, the colon bacillus, and other organisms are found in some instances. In the latter examples the condition resembles gonorrhœa but is of milder nature and usually associated with

a retained catheter, an impacted stone, or gout; the diagnosis turns on a microscopical and bacteriological examination of the urethral discharge.

The *treatment* of such milder varieties of urethritis is by removing the foreign body or rendering the urine less acid, and if due to retention of a catheter, by irrigating the urethra around the instrument with weak permanganate solution, eventually removing the instrument.

GONORRHŒA. The gonococcus, though capable of infecting many parts of the body, finds its most congenial habitat in the urethral mucosa, and this is the point from which further infection generally originates.

The infection follows on sexual congress, the coccus invading the epithelium of the anterior urethra and setting up a purulent catarrh (blenorrhœa) of the membrane, to which it may remain localized, or it may spread to the deep urethra and glands opening into the urethra (mucous follicles and Cowper's glands), to the ejaculatory ducts, and hence to the vesiculæ seminales, epididymes, &c. ; the spread is along the lymphatics surrounding the urethra.

Spread to more distant parts, such as the joints, is described in the general account of Gonococcal Infection (vol. i, p. 172).

Symptoms and Signs. Itching of the meatus commences two to three days after infection, and a scalding sensation on passing urine shortly follows. The lips of the meatus stick together and are œdematous. In about five days there is a mucoid discharge, and within ten days this becomes thick, copious, and of yellow muco-pus, while the scalding sensation is more severe : this stage lasts some days. After about three weeks the discharge becomes less and is of a thinner consistency, the subjective sensations becoming less marked. This stage, known as " gleet," may last a few weeks and then clear up or may persist almost indefinitely unless carefully treated. Moreover, even where there is no obvious discharge except possibly a slight glueing of the meatus in the morning, there may be gonococci in the lacunæ of the urethra and the patient be quite capable of affecting others or of developing an attack of acute urethritis should the urine become very acid or after indiscretions of dietetic, alcoholic, or sexual nature ; once the infection has spread to the posterior urethra a gleet is likely to become very protracted.

Diagnosis. This is only complete when microscopical examination has been made, and implies finding of intracellular, semilunar diplococci which decolorize by Gram's staining method. In fresh cases the discharge can be readily milked from the urethra and may contain gonococci in pure culture, but in chronic cases of gleet, where the discharge is scanty, the two-glass test, following prostatic massage, should be employed and the threads and flocculi from the first glass stained and examined for the organism ; or where the diagnosis is highly important, as where the question of a prospective marriage arises, the urethra is irritated by injecting 1 per cent. silver nitrate to cause a transient acute urethritis, which will bring the cocci into the urethra.

Treatment. Owing to the intractable nature of some cases, especially if neglected, and the number and variety of complications which may result from the spread of this disease, not only to the patient himself but also to his intimates, the importance of getting rid of the infection rapidly is obvious. Prophylaxis is perhaps the most important part of all, and is dealt with under the general description of Venereal Disease (vol. i, p. 211).

In general we aim at diminishing pelvic congestion and increasing the flow of non-irritating urine ; this alone may affect cure in the milder cases. The bowels are maintained freely open and the urine kept bland and diuresis promoted by administering potassium citrate grs. 15, sodium bicarbonate grs. 15, tincture of hyoscyamus half a dram, thrice daily. The patient is encouraged to drink plenty of milk, lemonade, and soda-water ; alcohol is strictly avoided, and the diet light. In the more acute forms it is sound practice to keep the patient in bed for a few days at the commencement. Later, exercise should be mild and horse- or bicycle-riding avoided ; coitus is, of course, out of the question till the disease has been cured for some months.

Where there is much irritation and painful erections, hot baths are very comforting and soothing, and for the latter condition thirty grains of potassium bromide should be given overnight. Frequency of micturition is encouraged to wash out the urethra, the urine being voided every two hours or oftener. As regards drugs, sandal oil in doses of ten minims, given in capsules, diminishes irritation, but its action as a curative agent is slight. Urotropin renders the urine antiseptic, but is perhaps of use rather by increasing the secretion of urine and so causing a more frequent lavage of the urethra.

Local treatment consists of irrigations and injections.

The so-called abortive treatment consists in injecting a solution of 1 per cent. silver nitrate after cocainizing the urethra, and is advocated by some in the early stages. The value of this method is questionable and it may greatly increase the severity of the inflammation ; therefore we do not recommend it. In general it is well not to employ local treatment till there is a definite purulent discharge, and then the urethra is washed out frequently with very dilute astringent solutions. The solution may be introduced by means of an irrigator with a nozzle of the Janet type or a small glass syringe ; in any case the urethra is first washed out by passing urine immediately before the treatment.

Where the irrigator is used the nozzle is introduced into the urethra, the meatus being alternately held close round the former and relaxed so that the fluid can escape ; in this way the anterior urethra is washed out down to the compressor-urethræ muscle. Where the posterior urethra is affected (as is detected by employing the two-glass test after washing out the anterior urethra, when threads will be found in the first glass) the compressor urethra is paralysed by injection of novocain (4 per cent.) and the douche-tin attached to the irrigator raised to five feet above the penis and the nozzle held firmly in the meatus. The pressure of fluid overcomes

the compressor-urethræ and the fluid washes out the posterior urethra into the bladder till the latter is full, when it is emptied by voluntary micturition.

The posterior urethra may also be washed out by passing a soft catheter till it is just beyond the compressor-urethræ (easily noted by the resistance felt) and the wash given as for washing out the bladder.

One or two pints of solution are used and permanganate of potash, varying in strength from 1 in 8000 to 1 in 2000, is employed. The anterior urethra may be distended with solution injected with a small syringe after micturition, the solution being retained by holding the lips of the meatus together for five minutes. Besides permanganate the following solutions are useful : zinc sulphate one grain to the ounce, protargol $\frac{1}{2}$ per cent. These solutions are increased in strength later, but at first should not cause irritation.

Irrigation may be done once daily, injections two or three times, and may supplement the former treatment ; irrigation is the more thorough method.

The treatment of *gleet* is difficult, and it is needful to investigate the interior of the urethra with the urethroscope so that suppurating follicles, early stricture, &c., be not missed. In these cases prostatic massage followed by irrigating the deep urethra, treating follicles and strictures, and instilling 1 to 5 per cent. silver nitrate into the deep urethra, is to be tried, while improving the general health by tonics and mild exercise in the open air is indicated.

LOCAL COMPLICATIONS OF GONORRHŒA. In addition to the complications described in an earlier chapter certain local complications are worthy of note :

(1) *Ulceration of the Urethra with Hæmorrhage.* A slight tinge of blood in the urethral discharge is not uncommon if the attack be severe, but occasionally a small ulcer spreads deeply and penetrates a vessel of some size in the wall of the urethra, causing severe bleeding. The fact that the blood pours from the urethra independently of micturition and during an attack of gonorrhœa makes the diagnosis.

Treatment. Injection of a mixture of equal parts of 10 per cent. cocain and adrenalin (1 in 1000) will check the bleeding in most cases, or the penis may be firmly bandaged for a few hours ; this last plan cannot be prolonged on account of the pain.

(2) *Balanitis,* or inflammation of the prepuce and glans, may be acute or chronic. The mucous surface is red, œdematous, and secretes pus. This usually is found where the foreskin is long and cannot be retracted. Later crops of warts develop around the corona glandis.

Treatment. If the foreskin can be retracted cleanliness and antiseptic washes will rapidly cure, but if, as is usual, there be phimosis the prepuce should be slit up freely on the dorsum to permit of local cleanliness and exit of discharge ; later circumcision may be performed.

(3) *Chordee* is the name of painful erections occurring in the course of gonorrhœa, caused by infiltration of the corpus spongiosum or cavernosum,

the penis being often bent to one side. The condition is very painful and occurs in the early morning. Purges, full doses of bromide before going to bed, and hot baths will relieve.

(4) *Suppurating follicles* are noted as tender swellings usually on the floor of the urethra, and these should be opened, with the help of the urethroscope, into the urethra, as if bursting on the surface there is some danger of a penile urinary fistula forming, which may be difficult to cure.

(5) *Inflammation of Cowper's glands* is likely to result in the formation of an abscess in the perineum, on one side of the middle line. Such an abscess may burst into the urethra, and if this does not occur and the presence of pus is diagnosed by fluctuation, the abscess should be opened and drained from the perineum.

(6) *Posterior Urethritis.* In a certain number of instances infection of the posterior or prostatic urethra takes place. . Owing to the various ducts and lacunæ opening into this part of the urethra, lavage is less satisfactory and the condition is likely to become chronic and intractable. The persistence of gleet is in most instances due to infection of this part of the urethra. The condition has been discussed under Chronic Prostatitis, of which posterior urethritis is a dominant feature.

Starting from the posterior urethra, it is easy to understand the passage of infection to the prostate, vesiculæ, epididymis and bladder, described elsewhere under the heads Prostatitis, Vesiculitis, Epididymitis, Cystitis, &c.

STRICTURE OF THE URETHRA. By this term is understood a narrowing of the calibre of the urethra due to contraction of fibrous tissue, the result of past inflammation and ulceration. This condition is sometimes known as organic stricture, in contradistinction to false or functional stricture, in which there is no permanent narrowing of the urethra but a temporary stenosis, sufficient to cause retention of urine, *i.e.* no real " stricture " at all.

(a) *Functional Spasmodic or False Stricture.* Such temporary blocking of the urethra may be due to spasm of the compressor-urethræ muscle (the usual cause) or of the sphincter at the neck of the bladder, occasionally to congestion of the urethral mucosa, the former being known as spasmodic, the latter as congestive stricture : the two conditions are often present together, and certainly, where congestion is present, in most instances the ultimate factor causing the block is spasm of the compressor-urethræ.

Thus, retention of urine may occur during an attack of acute urethritis, partly from œdema of the mucosa but more from the sphincter-spasm set up by the irritable condition of the inflamed mucosa. Pure reflex spasm is caused by operations on the rectum, spermatic cord, *e.g.* for piles, varicocœle or hernia, and by injuries to the perineum such as contusions of the urethra. Further, in a patient with an organic stricture of large calibre (not nearly tight enough to produce retention), exposure to cold or excess, whether in alcohol or sexual activity, may cause congestion and spasm, sufficient to produce retention. To sum up, false or functional stricture is an acute

condition leading immediately to retention of urine, while organic stricture is a slowly progressive narrowing of the urethral channel which is liable to give rise to an attack of acute retention at any moment.

Treatment of Spasmodic Stricture. Hot fomentations to the perineum and pubis, or hot baths, together with the administration of thirty minims of tincture of opium, will generally relieve the resulting retention of urine. Where this fails a soft catheter can usually be introduced after cocainizing the urethra if the latter be very sensitive ; a silver catheter will seldom be needed.

(b) *True or Organic Stricture of the Urethra. Causes.* (1) The most usual cause of urethral stricture is in sequence of a continued urethritis of gonococcal origin. The submucous tissue of the urethra is always involved to some degree, and where the inflammation is prolonged the exudate does not undergo resolution and absorption, but fibrous tissue is laid down which contracts, after its custom, and so narrows the urethra ; this is a great reason for aiming at the rapid cure of urethritis. Where abscesses form about the urethra the chances of contraction are still greater, and ulceration due to urethritis is a fertile source.

(2) Rupture of the urethra is a not uncommon cause, from the gross scarring which results in the damaged urethra; this indicates the need for careful suturing of these cases at their commencement and for removal of hopelessly damaged portions to promote primary union as far as possible with the minimum of scarring. Where a perineal fistula results from rupture of the urethra a stricture will surely follow, and this of the hardest and most refractory type.

(3) From scarring about an ulcer caused by an impacted stone or foreign body.

(4) Contraction of a chancre at the meatus or other inflammation here may cause a meatal stricture.

(5) Rarely congenital stenoses and valves are found along the urethra. In such cases the back-pressure of the retained urine has often dilated and destroyed the kidneys, so that life is not prolonged. The " pinhole meatus " of congenital origin, as has been mentioned, is common.

POSITION OF STRICTURES. Strictures are found in all parts of the urethra with the exception of the prostatic position, and stenosis sometimes results here after suprapubic prostatectomy.

(a) The commonest situation is in the bulbo-membranous part, both from trauma and urethritis. The reason of the frequent occurrence in this situation from the latter cause is probably that the bend of the penis in the dependent position tends to promote retention of inflammatory exudate and consequent inflammation. This is the common position for tight strictures such as cause retention of urine.

(b) About one-third of strictures occur in the penile part of the urethra ; these are usually of large calibre and always of inflammatory origin ; penile strictures seldom cause retention and are often overlooked unless a careful search be made.

(c) At the meatus is found the congenital, pinhole type and those due to contraction of chancres.

Multiple strictures are fairly common, and when investigating a case with a tight bulbar stricture it is not unusual to find one or more strictures of large calibre in the penile part.

VARIETIES OF STRICTURE. When surrounding the whole lumen the stricture is described as "annular," when involving a part only of the circumference the term " bridled " is employed, while where the urethral wall is much thickened so as to be palpable from outside the terms " indurated," " gas-pipe " or " tunnelled " are used. An important distinction is between " impassable " stricture, where no instrument can be passed, and " impermeable," in which urine will not pass, i.e. in which retention is present.

Thus a spasmodic stricture is impermeable, since retention is present, but it is passable to even large instruments, while a tight organic stricture is frequently impassable to even small instruments while permeable to urine.

A resilient stricture is one which can be readily dilated but soon contracts again. The terms sensitive, recurrent, tortuous, &c., explain themselves.

Anatomy and Consequences of Strictures. These concern the urethra, bladder, and kidneys.

(1) The urethra in front of the stricture is unaltered unless it be for the results of ill-directed attempts at passing instruments, in the shape of laceration and the openings of false passages.

(2) At the site of the stricture the urethra is narrowed and surrounded by scar-tissue to a varying length and a varying amount of its circumference ; the inner surface of the stricture is ulcerated, and granulations often project into the urethra.

(3) Behind the stricture the urethra is dilated, sometimes to a considerable degree, and may form a sort of cyst ; the walls are softened, often inflamed, and the lacunæ and glands of Cowper may become infected. The urethra under these conditions may easily give way, the smaller exudations of infected urine leading to a peri-urethral abscess, the large extravasations to gross effusion in the perineum and scrotum, ending in gangrenous cellulitis.

From the diseased urethra infection will travel back to the prostate, vesiculæ and epididymes, so that inflammation of these is a not uncommon complication of stricture.

(4) The bladder at first becomes hypertrophied, the muscular trabeculæ standing out obviously ; later it becomes dilated and sacculated as well, and, owing to the decomposition of the stagnant urine, cystitis soon follows and phosphatic calculi are formed.

(5) The ureters and kidney dilate under the back-pressure, forming double hydronephrosis, and infection of these leads to pyonephrosis and pyelonephritis, which end the scene, death resulting from uræmia and general infection.

Symptoms and Signs. The main symptom in the earlier stages is increasing difficulty of micturition : the patient notices that he takes longer to pass water, that straining is necessary to complete the act, and this improves the flow ; the stream is diminished. As the diminution of outflow is gradual the patient may not notice this for some time, and an attack of complete retention, brought on by cold or excess of alcohol, may be the symptom which brings the patient up for advice Forking and twisting of the stream may be noted but are of slight moment. Frequency of micturition, noticed at first by day, arises when the bladder is losing tone so that some residual urine remains after micturition. A gleety discharge in the morning is common. Pain in the hypogastrium is felt later as the bladder dilates with residual urine, and there may be some dribbling at the end of micturition, which decomposes on the clothes and gives the patient a characteristic urinous odour. Pus disseminated throughout the urine is found when cystitis has developed, but the presence of threads in the first glass is characteristic of the usual accompanying gleet.

Examination of the urethra is made in the first place by watching the patient micturate. It is easy to see at once if the stream is diminished to any marked extent, but the cause of this diminution, whether from stricture, enlarged prostate, impacted stone, &c., can only be made out by examining the interior of the urethra. Palpation of the urethra from outside may reveal the presence of a " gas-pipe " stricture ; urinous fistulæ in the perineum and scrotum point to a stricture in the bulbar region. The interior of the urethra is investigated with the urethroscope and bougies. The urethroscope is introduced into the meatus, the obturator removed, the eye-piece fixed on, and air

Fig. 208. Stricture of the anterior urethra, showing dilatation of the urethra behind.

pumped in. The tubular speculum is passed along under guidance of vision : strictures of large calibre appear as whitish crescentic bands partially encircling the urethra ; the aperture of a tight stricture appears as a small orifice surrounded by puckered scars from which granulations often protrude. A drawback to the use of this instrument is that strictures of medium calibre in the anterior urethra may prevent its introduction for the inspection of a tight stricture in the bulbar portion of the tube.

Investigation with Bougies. With all antiseptic precautions and after anæsthetizing the urethra, if sensitive, a conical gum-elastic bougie (Cox's form is good) of large size is introduced ; this checks at some point if a stricture be present, and an instrument two sizes smaller is next tried and so on, till one is found which passes into the stricture but will not pass completely through. On attempting to withdraw the instrument the

latter is gripped ; such " gripping " is characteristic of a stricture ; the next size smaller will probably pass right through. In this manner the number and characters of strictures can be roughly estimated as regards density and length, provided (as is usual) that the anterior strictures are of greater calibre than those more posterior.

Some surgeons employ steel bougies for this purpose ; these are quite good for larger strictures but should not be used in sizes smaller than 6 (English scale) on account of the danger of causing false passages. Examination with a large sound or silver catheter has the advantage that an impacted calculus is readily detected. Before passing instruments acute gonorrhœa is excluded by squeezing out the urethra to produce any discharge ; the nervous system is investigated for tabes or disseminated
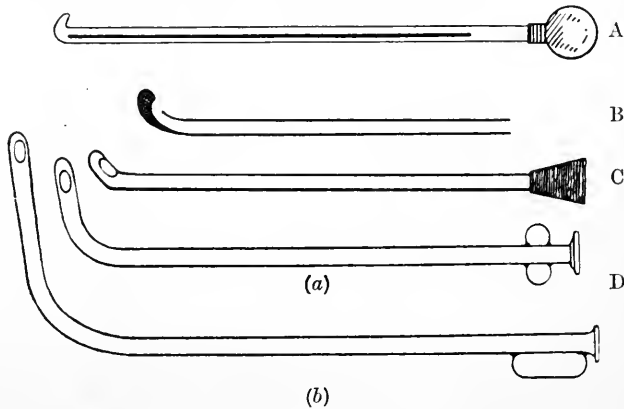
FIG. 209. A, Wheelhouse's grooved urethrotomy staff. B, Section of catheter, solid beyond the eye. C, Coudé catheter. D, Silver catheters : *a*, ordinary ; *b*, prostatic. Note the long intravesical portion of *b*.

sclerosis, and the rectum for growths of the prostate or bladder. The depth in the urethra at which the obstruction is found is of some value in diagnosis. The penile and bulbar portions together measure, roughly, six inches, and in this part strictures occur ; hence an obstruction more than six inches down is unlikely to be due to stricture.

Dangers of Instrumentation. (1) Shock, especially where instruments have not been previously passed or where the renal function is impaired. Anæsthetizing the urethra with novocain and keeping the patient warm in bed after passing instruments will usually prevent this.

(2) Bleeding from the formation of a false passage or laceration of the sodden mucosa is seldom severe, and should never be so if the instruments are used with proper delicacy. Injection of adrenalin will promote hæmostatis.

(3) " False passages " can hardly be made with soft instruments such as the bougies of Cox ; they usually result from the forcible use of steel bougies of small diameter, which is not good practice. The instrument is felt to pass on suddenly with a gritty sensation, and on examining the perineum or per rectum the point of the instrument is not in the middle

line (Fig. 210). The indication where this unfortunate accident takes place is to desist from further instrumentation for at least a week, the patient remaining in bed. If the bladder be distended and retention present this must be relieved by repeated aspiration of the bladder above the pubis with a fine needle, hot baths, &c.

(4) Local spread of infection, causing prostatis and epididymitis.

(5) General infection known as " urinary " or " catheter fever."

The pathology of this is not yet clear, and indeed conditions of very different severity are classed together under the expansive title of " urinary fever." *Infection*, whether from (*a*) the existing focus, viz. the stricture, which may be lacerated so that new channels for absorption are opened, or (*b*) from introduction of sepsis on an unclean instrument, certainly plays an important part. *Reflex irritation* of the kidneys in all probability plays some part, since in the severe cases which die these organs are in a condition of acute pyelonephritis. The point at issue is whether infection spreads by the blood-stream to kidneys, chronically damaged by back-pressure, and suddenly subjected to reflex-congestion, from insult to the lower urinary tract, or whether the spread is along the bladder and ureters to the kidney. The rapidity of onset and its severity suggests a blood infection, but Walker has

FIG. 210; Stricture of the urethra, in front of which a false passage (containing a fine bougie) leads into the bladder.

shown experimentally that bacteria are rapidly transmitted by the lymphatics from the urethra to the kidney. Catheter fever is more prone to arise in patients with impaired kidneys and on the first passage of instruments ; hence the special danger of instrumentation in prostatic cases. (*See* p. 539.)

Clinically the affection varies widely, and there may be :

(*a*) A single rigor with pyrexia up to 105° or thereabouts.

(*b*) Intermittent fever with repeated rigors lasting some days.

(*c*) Intermittent fever and rigors with signs of renal infection, thirst, anorexia, weakness, diminished secretion of urine, which may be purulent ; suppression of urine may occur and the patient die in a few days.

(*d*) The infection may be more generalized and pyæmic abscesses develop.

Prevention is the best treatment here, by special care in the sterilizing of instruments and the urethra, the latter being anæsthetized, while the patient

is kept warm in bed after the examination, especially where the renal function is lowered or where no previous examination has been made.

Treatment of Catheter Fever. The patient is kept warm in bed and given plenty of warm, demulcent fluid, as milk, weak tea, lemonade, and urotropin.

Further operations are delayed till acute symptoms pass off, unless absolutely needed to drain the bladder, when this should be done by the perineum for stricture (external urethrotomy) ; in other cases suprapubic drainage will be best. Where suppression of urine threatens, the blood-pressure is raised by saline infusion per rectum or intravenously ; digitalin hypodermically may be beneficial. As a last resource rapid exposure of the kidneys and stripping the capsule may be tried.

Prognosis in Cases of Stricture. If the stricture be dilated and kept of wide calibre in its early stages the outlook is good ; but if, as is common, the patient goes away to sea and fails to attend regularly, thus allowing the stricture to contract again, the kidneys are gradually damaged by back-pressure and fall a ready prey to infections, the patient perishing from infective nephritis years before his time.

Treatment of Stricture. As mentioned, it is essential to enlarge the calibre of a stricture till it is of normal size and, what is no less important, to keep it so. The latter is done by keeping the patient under observation for a long time after the stricture is dilated, the former in various ways suitable to different cases. Many plans have been devised of dealing with strictures ; the following at present best meet with the requirements of the patient and surgeon : dilatation with bougies, internal urethrotomy, external urethrotomy, excision.

(1) Dilatation by intermittent and repeated passage of bougies is the best method where it is applicable, viz. where the stricture is of more than two calibre (English scale), where the urine is healthy, and the patient has plenty of time to devote to his treatment. This plan is contra-indicated where there is cystitis, fistula or abscess in the perineum and where the stricture is resilient, contracting rapidly after dilatation ; it is unwise to attempt this plan for strictures only admitting a fine filiform bougie, as congestion following the passage of instruments is likely to cause retention, and in such cases false passages are easy to make. Dilatation is performed twice a week, the patient being prepared by taking a diuretic mixture containing urotropin. The urethra is washed out before and after dilatation with solution of oxycyanide of mercury 1 in 4000. To commence with, silk and gum-elastic bougies (Cox) may be used till the stricture is dilated to 7 (English scale) : at each sitting the stricture is enlarged one to three sizes, according to its dilatability. When the above degree of enlargement is reached steel bougies (Buckston Brown's or Lister's) may be used till 16–19 passes readily. Both these forms of bougie are graduated conically at the bend, forming a sort of mandril which dilates a stricture nicely. There should be no hurry in dilating by this plan. When the stricture is fully dilated a full-sized bougie is passed weekly for a month, then monthly

for six months, and then on quarter-days ; intelligent and clean patients can do this for themselves, with strict injunctions to come up for advice if unable to pass the instrument.

(1 *a*) Continuous dilatation with bougies has been employed. Where the stricture is very small, only admitting a whip or filiform bougie, the patient is kept in bed with the small bougie or catheter tied in ; after twenty-four hours it will be found that a bougie one or two sizes larger can be passed : the instrument must not fit tight if this method be adopted or irritation will follow. In a few days the stricture will be large enough to admit of intermittent dilatation. While the instruments are tied in, the urethra should be washed out twice daily with weak permanganate solution. As this method is likely to cause urethritis, rigors, urinary fever,
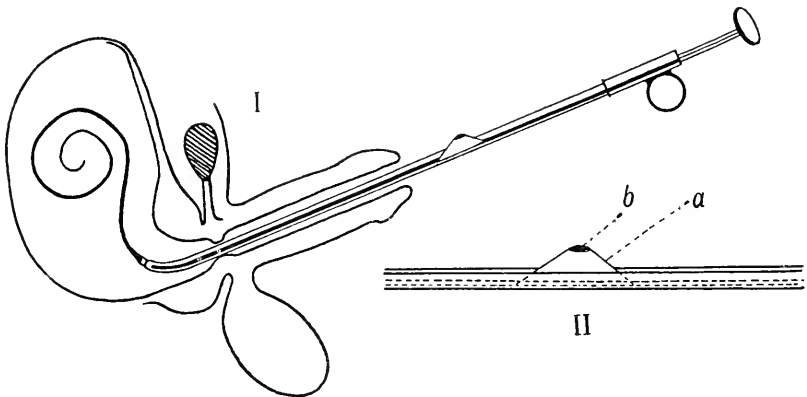
Fig. 211. I, Internal urethrotomy with Maisonneuve's instrument. Grooved staff in urethra ; filiform guide curled up in the bladder. Knife being passed. II, Showing the bulb (*b*), on the knife (*a*), which guards the normal urethra.

&c., we do not advise its use ; such cases are better treated by internal urethrotomy.

(2) *Internal Urethrotomy.* This method is indicated for patients who have not time to attend regularly for intermittent dilatation but can afford a week in bed (*e.g.* sailors between voyages) ; where the stricture is very tight, only admitting a filiform bougie, or where it is apparently impassable (in most instances such stricture will admit the passage of a filiform guide when the patient is anæsthetized) ; where the degree of urinary infection is but slight (where there is marked cystitis, external urethrotomy is the operation of choice) ; where the stricture is resilient and rebels against simple dilatation.

The patient is prepared with urotropin and by washing out the urethra as before, and is anæsthetized. The stricture may be divided from behind forwards or from before backwards ; as the former operation implies a calibre of the urethra of at least 4 English to permit the passage of an instrument through the stricture, and consequently extra manipulation to attain such a size without any corresponding advantage, the plan of dividing the stricture from before backwards is advised. There are several

instruments in use : the best seems to be that of Maisonneuve, in which the blade cuts fore and aft, so that when it has cut through the stricture it can readily cut its way out again ; for if there be a guard on the back of the blade, or if the latter be blunt, the blade may jam beyond, *i.e.* on the proximal side of the stricture, and necessitate a cystotomy and perhaps some blacksmith's work before it can be released. The first step is to introduce the filiform guide, which is of gauge one-half to one in size and very flexible ; by bending the end into divers shape this can usually be accomplished, but may require patience as well as skill. Injecting oil into the urethra or inspection with a urethroscope may help, but patient sounding with different shaped bougies is the most useful plan, remembering that the opening of the stricture is often at one side of the cul-de-sac formed by the stenosed urethra. When the bougie has passed the stricture, as is recognized by its easy passage into the bladder, the grooved steel guide is fixed to the female screw at the end of the bougie. The guide is a curved staff of 2 gauge and grooved on the dorsal (upper) surface to take the sliding knife. The steel guide is passed home into the bladder, its point being kept out of false passages by its forerunner, the filiform bougie, which curls up inside the bladder. The steel guide is brought down to an angle of 45° with the horizontal (the patient being recumbent) and the knife pushed down the groove in the guide, care being taken to see that the knife is properly in the groove. As the knife passes down its small, bulbous, central part raises the normal mucosa away from the blade till the stricture is recognized by its resistance ; firm pressure sends the knife through this, cutting the roof of the urethra, and the knife is gently pushed on again, other strictures being divided till the bladder is reached ; the knife and guide are then gently withdrawn. On no account should the knife be worked up and down the urethra several times or severe and dangerous bleeding will follow. The strictures are further enlarged by passing steel bougies, commencing with 9–12, passing up to 16–19. A drachm of 1 per cent. silver nitrate is next injected into the deep urethra with a soft catheter and small syringe, and the patient remains in bed for a week, after which a full-sized bougie is passed and the patient can go about again, with similar instruction as to passing bougies as after simple dilatation. *Note :* if much bleeding takes place as the cutting is done a large soft catheter is passed and tied in the bladder for twenty-four hours ; the pressure of the instrument will help to check bleeding and the instrument will prevent blood collecting in the bladder. Where slight cystitis is present a catheter may be tied in for two days and the bladder washed out. The only danger of this operation (apart from sepsis, which is uncommon) is hæmorrhage, and this can usually be avoided if care and precision be used. Where the bleeding does not cease after the catheter is tied in, the urethra should be exposed from the perineum (external urethrotomy) and the bleeding-point tied, or gauze packed round the catheter. Should bleeding take place in the absence of a catheter so that the bladder becomes filled with clot (clot-retention), attempts should be made to remove the clot by breaking it up

with a lithotrite and extracting with the evacuator, but usually under these circumstances it will be necessary to open the bladder above the pubes, turn out the clot, and pack the deep urethra with gauze for twenty-four hours.

(3) *External Urethrotomy.* The indications for attacking the stricture from the perineum are :

(*a*) For impassable strictures, where not even a fine bougie can be passed through under an anæsthetic.

(*b*) In the presence of complications such as :

    (1) Extravasation of urine.

    (2) Perineal abscess and fistula.

    (3) Severe cystitis.
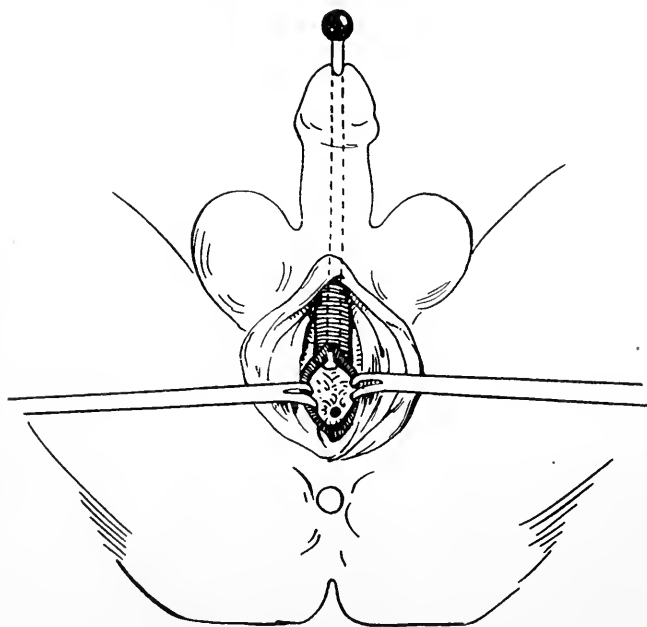
FIG. 212. External urethrotomy, showing Wheelhouse's staff with the loop forwards ; the urethra laid open and retracted ; the dark spot is the opening of the stricture amid granulations.

Since to perform the operation by Syme's method (with the shouldered staff) it was necessary that the stricture should admit an instrument of No. 2 size and therefore the more difficult cases were excluded, and since where the shouldered staff can be used the method of Wheelhouse is just as simple, the former method has dropped out of practical surgery and only the latter need be described.

The principle of Wheelhouse's external urethrotomy is to expose the normal urethra just in front of the stricture and trace the narrowed part of the tube back with fine probes till the dilated portion behind the stricture is reached, the stricture being divided as it is traced backward.

The patient being in the lithotomy position, the straight grooved staff

of Wheelhouse is introduced down to the stricture, with the grooved surface towards the perineum, and a median inch-and-a-half incision made on to the groove in the staff ; the normal urethra is thus opened half an inch in front of the stricture. The most important part of the operation is to strike the normal urethra in front, for if the staff has slipped into a false passage it is useless to trace this further. Therefore if there be any doubt, the urethra, or what is thought to be the urethra, should be slit up a little forwards till there is no doubt that the urethra is opened. When this is certain the staff is rotated so that the hook is forwards and made to pull the anterior part of the opening in the urethra upwards ; a pair of tissue-forceps on either side retract the sides of the opening in the urethra, and the face of the stricture is exposed, surrounded by granulations. A search is made with a fine probe-pointed director for the opening of the urethra, which is often at one side and obscured by granulations. Often several false passages will be slit up before the real passage is found. Finally the director will pass easily backwards, and this, together with the flow of urine, will show that the dilated urethra behind the stricture has been entered. The stricture is divided on the groove in the director and a gorget slid along the groove into the bladder, and along the gorget a large soft catheter introduced into the bladder. The other end of the catheter is then passed from behind forwards along the penile part of the urethra (the staff being removed) and secured to the prepuce with a stitch. The urethra is partially united over the catheter with fine plain catgut and the perineal wound closed in layers. The catheter is retained for a week or ten days if possible, and then bougies passed as after other methods : slight leakage may occur through the perineum, but a few cases heal *per primam* ; in any case the fistula seldom lasts long if the urethra be kept dilated with bougies. The patient remains in bed two to three weeks, according to the rate of healing. The above applies only to the uncomplicated cases, but where there is severe cystitis the catheter is brought out through the perineum and the wound but partly closed, bougies being only passed after some days, when the cystitis improves under drainage and lavage. Under these conditions bougies are passed at intervals or a catheter may be manœuvred into the bladder from the penis past the perineal opening, and kept *in situ* for a few days to permit of the perineal wound healing. Where there is great extravasation and sloughing the catheter comes through the perineum and no attempt is made to close the wound, which can hardly be too large.

(4) *Excision of Strictures.* This method is of use in the case of strictures where there is much induration, especially if they recur rapidly after internal or external urethrotomy. The stricture is exposed as for external urethrotomy and the mass of fibrous tissue excised ; the distal part of the urethra and corpus spongiosum is freed from its surroundings for some distance (two inches) and sutured round a catheter firmly to the proximal end of the dilated part behind the stricture, as after rupture of the urethra. We have been able to remove as much as an inch and a half to two inches of indurated and stenosed urethra in this manner and obtain good union.

Complications of Stricture. False passages and catheter fever have been already described ; the following remain to be discussed : cystitis, epididymitis, retention, and peri-urethral inflammation.

(1) Cystitis, if mild, is met with by internal urethrotomy, lavage, and urotropin internally ; but if severe, external urethrotomy will be the operation of choice, with perineal drainage and lavage.

(2) Epididymitis points to the need for avoiding instrumentation of the urethra till the complication has passed off, unless treatment is urgently needed as for retention.

(3) *Retention of Urine.* Reference has been made already to this condition ; inability to pass urine, though desiring intensely to do so, and the tense fluid swelling rising out of the pelvis are characteristic. Diagnosis from retention of other origin, such as enlarged prostate, impacted calculus, spasm of the compressor-urethræ, &c., is made by investigation with bougies and the urethroscope (pp. 586, 587).

Treatment. This is urgently needed. The patient is given thirty minims of tincture of opium and placed in a hot bath ; as a rule this will enable him to empty the bladder, and later it may be possible to pass a small catheter and perform intermittent dilatation or internal urethrotomy.

Where the bath fails to relieve the condition, and where no catheter can be passed, the bladder must be emptied by inserting a fine aspirating-needle into the bladder above the pubes. If pushed back immediately above the pubis there is no danger of injuring the peritoneum unless the bladder be contracted, which is unusual. Before aspirating the skin should be pierced by a small incision with a scalpel to lessen the effort required, or the sudden thrust, requisite to force the needle through the tough skin, may rupture the over-distended and weakened bladder. If the urine when aspirated proves to be foul no time should be lost in performing external urethrotomy and drainage, but where the urine is healthy aspiration may be repeated several times, and later it may be possible to introduce bougies and dilate .the urethra. As a rule internal urethrotomy should be done within one or two days. Where the bath fails and the surgeon has no aspirating-needle handy, as may happen in the far country, it will be necessary to perform *perineal section* (Cock's urethrotomy). This consists in opening the urethra from the perineum behind the stricture, where it is dilated. The patient being in the lithotomy position, the left forefinger of the surgeon is placed as a guide in the rectum and feels the apex of the prostate. The knife is then plunged into the middle line of the perineum, aiming at the tip of the finger but stopping a quarter of an inch short of it so as to avoid the rectum ; by a slight lateral movement the dilated urethra is opened just in front of the prostate, as shown by a gush of urine. A director is passed in the bladder along the knife and a gorget along the director, thus affording passage to a soft catheter which rests in the bladder and is fastened in the perineum with a stitch. The stricture is not touched, and after a few days may afford entrance to bougies or external urethrotomy may be done. In these days of telephones and motor-cars, Cock's operation

is seldom needed. Aspiration followed by internal or external urethrotomy is the usual procedure where the hot bath fails.

(4) *Peri-urethral Inflammation.* Two main types are found, peri-urethral abscess, and extravasation or gangrenous cellulitis.

(*a*) *Peri-urethral Abscess.* This is due to infection of the mucous glands of the urethra or of Cowper's glands, either by passage of organisms from the infected urine, or from softening and ulceration of the distended urethra allowing slight leakage behind the stricture ; such an abscess may burst into the urethra or on the surface, leading to perineal or scrotal fistula. In the latter instance the fistulæ may be multiple and the scrotum large and fibrosed, with many fistulous openings which discharge urine at each act of micturition.

The original abscess presents itself as a painful brawny swelling of the perineum in a patient with stricture ; fluctuation is noted as the abscess enlarges. These abscesses are distinguished from simple gonococcal abscesses of Cowper's glands by the presence of a stricture.

Treatment. The abscess should be opened and drained before it can spread to the surrounding tissue and cause multiple fistulæ, which are difficult to cure. The abscess is opened and drained from the perineum ; where it is large and acute an external urethrotomy (Wheelhouse) should be done at the same time, but where the abscess is of milder and more chronic nature an internal urethrotomy may suffice ; in any case efficient treatment of the stricture is most essential.

(*b*) *Extravasation of Urine and Gangrenous Cellulitis of the Scrotum.* This serious condition arises in various ways :

(1) The softened urethra behind the stricture may give way during straining as in the formation of a peri-urethral abscess, but the leak is a large one. This occurs in the bulbar region beneath Colles's fascia, and the urine diffuses, in the manner described under Rupture of the Urethra, to the perineum, scrotum, penis, and lower abdomen (p. 608, Figs. 206, 207).

(2) The wall of a peri-urethral abscess which communicates with the urethra may give way, leading to a similar condition.

(3) Cases are found where there is no stricture and urine passes freely by the urethra : it is stated that the infection in these cases arises from the urethra, but in some instances there seems reason to believe that this is not the case.

The urethra commonly gives way in the bulbar or membranous portion, when the spread is as described. If the rupture is behind the triangular ligament, and in some cases where the membranous part gives way, the extravasation is into the pelvic connective tissue, while occasionally it tracks back in the ischiorectal fossa round the rectum. The result varies in severity with the infective power of the urine ; if aseptic the tissues may be infiltrated for some days without much damage occurring or much constitutional disturbance, but more commonly the urine is foul and septic, in which case rapidly spreading cellulitis results, passing into gangrene, with a grave prognosis unless treated with dispatch and precision.

Signs. The onset is commonly sudden : while straining to pass urine a patient with tight stricture feels something give way and experiences a feeling of relief. The bladder empties partially and there is a fullness of the perineum and scrotum, which increases with each effort to pass water. In other instances there may be a history of a localized swelling in the perineum (perineal abscess) followed by similar symptoms. In other cases, where there is no stricture, the urine is foul and a swelling gradually appears in the perineum. Usually cellulitis and gangrene set in after a few hours, the skin of the perineum, scrotum, and lower abdomen become boggy, red and purple, finally black, crepitating and gangrenous, while later the sloughs of scrotal tissue separate, leaving the testes bare. Constitutionally the signs are severe in the more infective conditions : the temperature may be subnormal, the pulse feeble, the patient passing into collapse and death ; more usual is high fever with rigors and delirium, at first. Where the urethra gives way behind the triangular ligament the history is of stricture with retention, followed by severe infective symptoms, while an irregular swelling rising out of the pelvis and felt about the neck of the bladder gives a clue to the diagnosis.

Treatment. Surgical measures are urgently needed to drain the bladder and free the tissues of infective organisms, many of which are anaerobic (Jungano), whence the importance of long deep incisions to expose such organisms to the air. The patient being in the lithotomy position, a staff is passed down to the stricture and an external urethrotomy performed ; splitting the perineum and scrotum in the middle line from one inch in front of the anus to well between the testes, a tube is passed into the bladder ; in severe cases the scrotum may be split completely. If the urethra be gangrenous but not strictured the bladder is drained from the perineum in a similar manner. Where the urethra is unaffected the condition is probably not of urethral origin and the urethra is left intact. Having passed a large catheter or tube into the bladder, the skin of the penis and lower abdomen is incised freely if in a condition of cellulitis, but if simply infiltrated and not inflamed the drainage afforded by the large perineal incision will suffice ; there is no need to open the tunica vaginalis. In general, incisions should be few but long and deep. The wounds are dressed with fomentations and irrigated with peroxide of hydrogen lotion, and as soon as the patient's strength will allow he is placed in hip-baths of dilute lysol (minims 10 to the pint). The skin of the scrotum may slough away entirely, but the testes will soon be covered in again, the contracting scar-tissue pulling over fresh skin from the perineum and thighs. Diuretics, urotropin, generous diet, and stimulants form an important part of the treatment. It is most important to open perineal abscesses, before gangrenous cellulitis develops.

URETHRAL FISTULÆ. These may be secondary to peri-urethral abscesses, whether of gonorrhœal origin or following stricture ; they also arise after operations where the urethra is opened. Such fistulæ are found in the perineum, scrotum, and penis : the scrotal variety is often multiple (watering-pot scrotum).

The nature of these fistulæ is obvious from the discharge of urine during micturition.

Treatment. In the case of small perineal and penile fistulæ any stricture should be divided by internal or external urethrotomy, the fistula freshened by curetting, and a catheter tied in for a week.

Where the fistulæ are multiple and there is much induration, as in the scrotal cases, it is advisable to excise the fistulæ *en masse* and freely, down to the urethra, and then suture the resulting wound in the scrotum and perineum, dividing the stricture and tying in a catheter as before. In bad cases it may be good to institute suprapubic drainage till the fistula is healed, to avoid fresh contamination with urine. Penile fistulæ, if large, must be treated by plastic operations, paring the edges of the skin and mucosa and uniting in layers, carefully inverting the mucosa. Excision of the stricture is indicated in some of these cases, uniting the divided urethra by end-to-end anastomosis about a catheter.

CANCER OF THE URETHRA. This may arise by local spread of cancer of the penis (p. 633) or of the prostate (p. 602), but sometimes originates in the urethra itself usually at the site of an old standing stricture. The signs are those of stricture with considerable induration of the surrounding corpus spongiosum. The diagnosis will hardly be made before operation for a tight stricture is performed, when on performing external urethrotomy the nature of the induration surrounding the urethra becomes obvious. On treatment, local resection of the urethra and corpus spongiosum with end-to-end suture may be feasible : more likely complete amputation of the penis (p. 635) will be the only resource.

CHAPTER XXXV

SURGERY OF THE PENIS, TESTES, AND SCROTUM

The Penis : Anatomy : Injuries : Phimosis, Paraphimosis : Inflammation and Ulcers of the Prepuce : Cancer of the Penis.

The Scrotum and Testes : Anatomy and Development : Examination : Congenital Defects, Undescended Testis, Ectopic Testis : Torsion of the Testis : Contusions of the Scrotum : Vaginal Hæmatocœle : Injuries of the Testis, Cord, and Vas : Hydrocœle : Hydrocœles associated with Maldevelopment of the Processus Vaginalis : Vaginal Hydrocœles : Spermatocœles : Hydrocœles of Obscure Origin.

The Spermatic Cord : Funiculitis : Varicocœle : Tumours of the Cord.

Acute Orchitis : Acute Epididymitis : Chronic Epididymo-orchitis : Tuberculosis of the Testis : Syphilis of the Testis : New Growths of the Testis : Fungus Testis : Atrophy and Neuralgia of the Testis : Affections of the Vesiculæ Seminales : Eczema of the Scrotum : Cellulitis of the Scrotum : Œdema of the Scrotum : Elephantiasis : Cancer of the Scrotum.

THE PENIS

Anatomy. The penis consists of three elongated bundles of cavernous, erectile tissue, the two corporæ cavernosa arising as the crura from either side of the pubic arch, and the single corpus spongiosum arising from the triangular ligament. The three are bound together by a fascial tunic to form the body of the penis, the cavernous bodies occupying the dorsal, the spongy body the ventral position. The latter is traversed throughout its length by the penile urethra, and expands into the glans penis at its free extremity. The skin of the penis is thin, elastic, lax, soft, and hairless ; the subcutaneous tissues are very loose, which accounts for the huge œdema which easily occurs here. The skin at the end of the penis forms a fold, the prepuce or foreskin, covering the glans. The inner surface of the prepuce assumes the character of a mucous membrane, and the glands at the junction of the prepuce with the corona glandis secrete the white tallowy smegma. The main surgical interest centres round the prepuce, especially if tight, showing the intrinsic soundness of this part of the Mosaic law, for the circumcised are practically immune to several diseases.

Injuries of the Penis. External violence, such as horse bites, strenuous coitus, &c., may lead to breaking of the penis or rather rupture of some vessels in the corpus cavernosum, causing immediate and great swelling, followed later by fibrous shrinkage of the part affected, so that the penis no longer can assume the normal erect position, but bends sideways. More rarely the penis is dislocated out of the skin lying beneath that of the scrotum or thigh.

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Rings or strings placed round the penis may lead to great œdema of the distal portion followed by gangrene if not removed in time.

INFLAMMATIONS OF THE PENILE BODY. These have been mentioned as a complication of severe urethritis (chordee), and may also lead to deformity of the penis from subsequent fibrosis (p. 613).

THE PREPUCE

PHIMOSIS. Phimosis or narrowing of the preputial meatus is usually of congenital origin, but is sometimes due to the contraction of scar-tissue resulting from venereal ulcers, old-standing gleet, balanitis, &c. In marked instances the preputial meatus may be so small that retention of urine occurs leading to distension of the bladder and double hydronephrosis. Where the prepuce cannot be freely retracted so as to expose the glans the condition is to be regarded as one of phimosis and treated as such.

The consequences of phimosis are various and far-reaching, locally and generally, physically and psychically.

Locally, the difficulty of keeping clean the apposed surfaces of glans and prepuce, causes secretion to be retained, leading to irritation, and the entrance of infective organisms sets up inflammation known as " balanoposthitis."

The same difficulty of maintaining cleanliness renders the subjects of phimosis more prone to the attacks of the spirochæte of syphilis, and where such infection is present the retention of discharge renders the resulting inflammation more severe and liable to become phagedenic or gangrenous. In later life the prolonged attacks of chronic inflammation strongly predispose to epithelioma ; indeed, apart from phimosis, cancer of the penis is extremely rare. In children the irritation of retained secretion leads to nocturnal enuresis and may be a factor in epilepsy, while the constant pulling at the foreskin, thus induced, leads to priapism and masturbation, causing precocious sexual unrest.

When the stenosis is tight enough to cause difficulty of micturition the consequent straining may lead to the descent of herniæ and prolapse of the rectum. Finally the condition known as *paraphimosis* may arise.

Treatment. Seeing the numerous ill-effects of an overlong and overtight prepuce there can be no doubt that unless this fold of skin is short and easily retractable, so as to admit of ablution, it should be removed by Circumcision, and it may fairly be stated that the importance of circumcision in infancy is hardly less than that of vaccination. The operation should be done, for choice, during infancy, since it is a much smaller operation at this period, and later in life the prepuce may become so adherent to the glans that the operation becomes no longer possible.

Operation. The penis having been cleansed with iodine solution the prepuce is drawn down so that the line of section is level with or slightly behind the corona ; the skin being flaccid the prepuce is held with sinus- or circumcision-forceps directed down and forwards so that the under surface is cut longer than the upper. The prepuce in front of the

forceps is cut off with sharp scissors, and the sinus-forceps being removed, the remaining prepuce retracts round the corona. The inner or mucous layer of the foreskin, thus exposed, is slit up with blunt-pointed scissors, carefully avoiding injury to the glans and urethra, and is stripped back to the corona, which is recognized by the collection of smegma around it. The mucous layer of the prepuce is then trimmed off, leaving a collar one-eighth inch wide round the glans ; any bleeding-points are tied, and
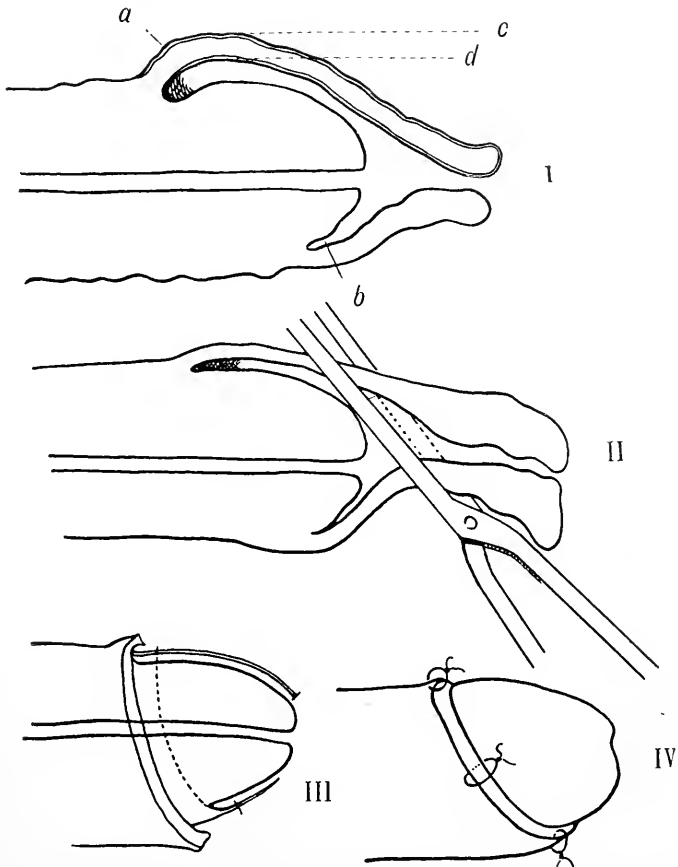
Fig. 213. Circumcision. I, Penis in section. *a*, *b*, Line of removal of prepuce. *c*, Skin. *d*, Mucosa of prepuce. II, Prepuce secured with forceps. III, Skin of prepuce removed, mucosa still has to be cut away. IV, Suturing skin to mucosa around the corona.

in the case of infants a single suture fixes the pointed end of the lower part of the skin to the frænum and checks bleeding. In older patients the skin and collar of mucosa are united with interrupted sutures varying in number with the size of the organ ; continuous sutures should not be employed or a condition akin to paraphimosis, from strangulation of the glans, may arise. The line of incision is dressed with a strip of gauze covered with sterile boric ointment to prevent sticking, and this is changed daily or when soaked with urine. If any signs of inflammation arise the

patient is placed in a hip bath of boric lotion or weak lysol twice daily.
In adults painful matutinal erections are likely to cause trouble and burst
the sutures, these are best treated with stiff doses of potassium bromide
at night. Finally, where circumcision is done in children in whom there
are signs of an irritable bladder the latter should be examined with sound
and per rectum to eliminate vesical calculus, which may be the real cause
of the symptoms.

PARAPHIMOSIS. This results from retraction of a tight prepuce behind
the corona, behind which the narrow meatus becomes jammed. The
consequence is that great œdema of the lax tissues of the prepuce results
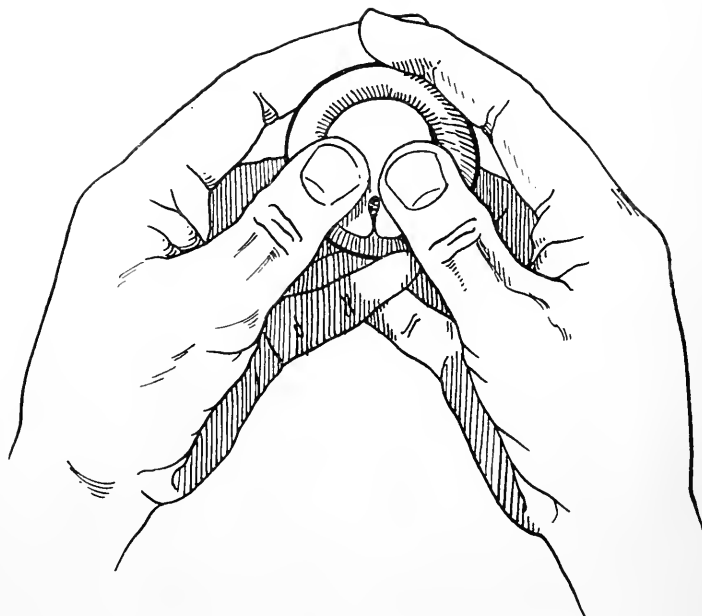
FIG. 214.   Reduction of a paraphimosis.

from strangulation of the vessels, and there is some œdema and swelling
of the glans ; if not reduced the strangulation becomes more severe and
will ultimately lead to ulceration and even gangrene of the strangled parts.
The condition is found usually in young boys, the prepuce having been
retracted and the patient being unable to reduce it ; it may also occur
during early attempts at coitus.

Treatment. Reduction should be done as soon as possible. The patient
lying on his back, the surgeon takes the penis, behind the corona, between
the first and second fingers of both hands, and with the thumbs compresses
the œdematous tissues of the prepuce and glans so as to push the latter
back through the constriction. Where œdema is very great the everted
prepuce should be punctured in several places and firmly bandaged for
a few minutes to squeeze on the œdema before attempting reduction.
Finally, where these measures fail, a director is slipped under the con-

striction, between the latter and the dorsal surface of the glans, and the constricting band formed of the narrow preputial meatus completely divided, till reduction is possible. After reduction the painful swelling is dressed with lead lotion, and after a few days, when acute signs have subsided, circumcision should be performed or paraphimosis will recur.

INFLAMMATIONS OF THE PREPUCE. *Balano-posthitis* or suppurative inflammation of the mucosa of the prepuce and glans is commonly associated with phimosis, being due to dirt, infection with various pyogenic organisms, or with the organisms of gonorrhœa, soft-sore, or syphilis. This affection, if untreated, may pass on to severe ulceration and even gangrene.

Treatment. The prepuce is slit open on its dorsum to the corona and the surface of the glans freely exposed ; the inflammation may be treated with lead lotion if mild, or fomentations, irrigation with peroxide of hydrogen, baths of dilute lysol, &c., if more severe, while if phagedenic ulceration be present the surface should be curetted and painted with pure carbolic to commence with. Later, when the acute inflammation has subsided, circumcision may be needed to form a more shapely organ.

ULCERATIONS OF THE PREPUCE. Herpes preputialis occurs as one or more crops of small vesicles, preceded by pain and uneasiness in the penis, and possibly down one leg tingling sensations may be noted. In two days the vesicles become tiny ulcers, which are very tender at first, but if kept clean heal up in about a week ; recurrence is common. The cause is unknown ; gout is blamed by some, but irritation from clothes or in sexual intercourse is probably responsible in most cases. The condition is of little importance if cleanliness be maintained ; but if infected severe inflammation may ensue. Particularly therefore is sexual intercourse to be avoided while these small ulcers are present, as the raw surface affords an obvious point of entry to the spirochæte, Ducrey's bacillus, &c.

Chancres, both hard and soft, have been discussed under General Infections (vol. i, pp. 173, 189, 200).

PENILE WARTS. These are found chiefly along the corona glandis as a sequel to prolonged balano-posthitis, and especially when of gonococcal origin ; they appear as red, pointed projections with purulent discharge.

Treatment. If small, these warts will disappear with cleanliness, and dusting the parts with a powder, consisting of equal parts of calomel, boric acid and starch. Where large and abundant, they should be snipped off under novocain anæsthesia and their bases touched with pure carbolic ; later circumcision is advisable.

ELEPHANTIASIS OF THE PENIS. This is a hypertrophy of the cutaneous tissues of the organ usually due to filariasis, in the more pronounced cases but cicatricial contraction of the lymphatics in the groin after venereal infection may lead to a less marked degree of elephantiasis. The treatment consists in removal of redundant skin by a plastic operation.

CANCER OF THE PENIS. This nearly always commences under a tight prepuce and is the result of constant irritation from repeated attacks of

balanitis ; if is rare under forty-five and is usually met with in old men. Where circumcision has been performed in early life this disease is almost unknown.

There are various conditions antecedent to well-marked cancer :

(a) As the result of prolonged irritation the skin of the glans becomes thickened and forms whitish patches, similar to the leucoplakia of superficial glossitis : after a longer or shorter interval the epithelium of these patches invades the connective tissue and the condition is definitely cancer.

(b) In other examples, raw weeping areas appear on the surface of the glans either independently or associated with leucoplakia. On microscopic
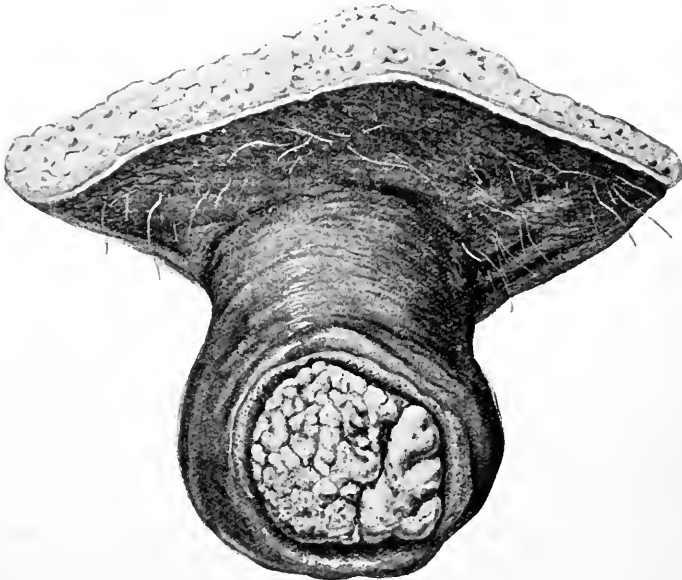
FIG. 215. Epithelioma of the glans penis, showing the indolent, irregular corrugated surface of the ulcer.

examination the epithelium is seen to be invading the deeper structures, and the affection is akin to Paget's eczema of the nipple.

(c) In other instances again, warty growths appear on the glans or corona, the infiltrated bases of which shows that epithelial invasion is progressing. The factors responsible are a tight foreskin, prolonged and chronic inflammation, and advancing years ; the first two are preventible.

Signs. A chronic discharge of pus from under a tight prepuce in a middle-aged person with palpable induration suggests the presence of cancer. As the growth spreads there will be found an ulcer with everted, hard edges, and indurated fixed base spreading into the body of the penis, sometimes fungating, in other instances with a somewhat sloughy, unhealing floor. The inguinal glands are soon affected and felt as painless bullet-like buboes ; when the growth is invading the body of the organ the iliac glands are likely to be affected.

Diagnosis. This has to be made from syphilitic ulceration and venereal warts. From chancres the greater hardness, everted edges, the often sanious discharge, the advanced age, and tight foreskin usually distinguish, but in doubtful cases scrapings should be examined for spirochætes, the serum reaction tested, and finally, if not satisfied, a piece of the edge should be removed for microscopical examination, since a hypertrophic chancre at first sight closely resembles a cancer. From gummatous ulcers the diagnosis is as in other forms of superficial cancer, but it should be recognized that cancer may take origin in a gummatous ulcer. From venereal warts the softness and multiplicity of the latter readily differentiate.

Treatment.—Occurring in a middle-aged person, a discharge of pus from under the foreskin indicates the need of slitting up the latter and examining the underlying glans penis.

If leucoplakia or a weeping eczematous condition be found, the affected part should be freely excised, *i.e.* most of the glans is removed and the urethra sutured to the skin. The part removed should be examined microscopically, and if definite cancerous changes are present a wider excision with removal of the inguinal glands should be practised. Where the diagnosis is certain, complete amputation of the penis and removal of the inguinal glands in one piece should be practised, since partial amputation is more likely to be followed by a local recurrence and probably shortens the penis to such a degree that micturition in the erect position is inconvenient, to say the least. Partial amputation should be reserved for those cases where the patient's age and condition render him an unpromising subject for the more complete operation, which is tolerably severe.

(1) PARTIAL AMPUTATION OF THE PENIS. The patient is in the dorsal position and hæmorrhage is controlled by an elastic rubber tube round the base of the organ. A dorsal flap with square corners is dissected up well behind the growth and about an inch and a half in length, the corpora cavernosa are divided, transversely, at the base of the flap, but the corpus spongiosum is cut about half an inch longer and brought through a slit in the flap. Bleeding-points are tied and the flap sutured in place. The urethra is split and secured with sutures to avoid any stenosis. The inguinal glands are excised, as described in the next operation.

(2) COMPLETE REMOVAL OF THE PENIS AND INGUINAL GLANDS. The patient being in the lithotomy position, the bulb and origin of the corpus spongiosum are exposed by a median, vertical incision, splitting the scrotum. The corpus spongiosum is dissected up in front to its union with the corpora cavernosa, where it is divided, stripped back and sutured to the skin of the perineum, the urethra being split to avoid stenosis. The incision is next carried round the root of the penis, the testes are retracted on either side and the crura exposed. These are separated from the pubic arch with a sharp chisel, and their arteries of supply and the dorsal arteries of the penis tied. The suspensory ligament is divided, and the penis is now only attached by the fat and lymphatics leading to the inguinal glands. The perineal wound is closed and the legs

brought down, the patient being in the dorsal position.   Incisions are carried out from that encircling the penis, along each groin, parallel with Poupart's ligament.   The skin is reflected up and down from these last incisions, and the fat and glands thoroughly removed down to the femoral sheath and Poupart's ligament, and dissected away over the front of the pubis till the root of the penis is reached.   In this manner the penis and the whole area of lymphatic drainage are removed in one piece.   A catheter is passed into the stump of the urethra in the perineum to avoid soiling of the dressings.   When the wound is healed the patient micturates in the sitting posture, or may employ a hollow cone of vulcanite or celluloid to act as an artificial penis and assist micturition in the erect posture, the broader part of the cone fitting the perineum, the apex being brought outside the clothes.
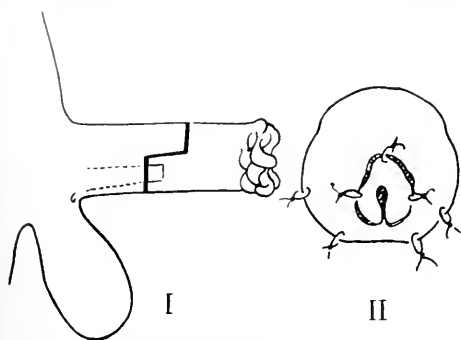
Fig. 216.   Amputation of the penis by a long dorsal flap.   I, Position of flap: urethra left long.   II, End view, flap sutured and urethra brought through flap and secured.

THE SCROTUM AND TESTIS

Anatomy and Development. The testes are developed in the posterior part of the abdominal cavity in close relation to the kidney, which accounts for their blood- and nerve-supply and lymphatic drainage being segmentally almost identical with those of the latter organ.   The testes descend in the later months of fœtal life and pass through the inguinal canal into the scrotum, pushing before them the abdominal tunic to form their covering in the scrotum.   From the external oblique is derived the intercolumnar or external spermatic fascia ; from the internal oblique the cremasteric fascia and cremaster muscle ; from the transversalis the internal spermatic or infundibuliform fascia ; while from the peritoneum is derived the tunica vaginalis.

The *gubernaculum*, a band of involuntary muscle, seems to be concerned to some degree in the descent of the testis.   This is attached above to the testis and the surrounding peritoneum, below to the pubis, the abdominal wall outside the inguinal canal, and the bottom of the scrotum.   It is easy to understand how the two former lower attachments can pull the testis down to the lower end of the inguinal canal, but how the part attached to the bottom of the scrotum can pull the testis into the latter pouch is not easy to conceive, it might as well pull the scrotum up inside the abdomen ; descent of the testis cannot be entirely explained by the mechanical action of the gubernaculum.   The testis, with the epididymis close behind, lies at the back of the tunica vaginalis and projects into the latter, being secured by the folds of *mesorchium* which normally gives a firm attachment.   The vas deferens or duct of the testis starts at the lower pole or globus minor of the epididymis, and runs up on the inner surface of the

latter to reach the spermatic cord. The cord consists of the three layers of spermatic fascia, containing the vas and its artery, the spermatic arteries and veins coming from the aorta and running to the inferior vena cava and left renal vein respectively, the lymphatics of the testis coursing to the lumbar and iliac glands, the nerves of the testis derived from the renal plexus, and finally the processus vaginalis, which is normally obliterated to form a fibrous cord. In addition to the spermatic fascia derived from the abdominal wall, each testis has a special tunic, the dartos, or deep layer of the superficial fascia, which is continuous with Colles's fascia behind, and with that of Scarpa in front.

Examination. The condition of the cord in the canal and at the external ring should be noted, and if this be of normal size the condition is almost certainly purely scrotal. Where the cord is enlarged high up, there may be some protusion from the abdomen such as a hernia or a hydrocœle or hæmatocœle of the cord. Where the swelling extends up the canal and is rounded and tense without impulse on coughing, it may be a strangulated hernia, in which case there will be, in addition, signs of intestinal obstruction, but should these be absent it will be a hydrocœle of a hernial sac or of the cord.

Where the swelling is purely scrotal its consistency, shape, and surface should be noted. When smooth and ovoid, the swelling is probably the tunica vaginalis distended with fluid or blood : *transillumination* will settle this point ; sometimes tumours of the testis are smooth and ovoid, but more often irregular. To test for translucency the surgeon stands in front and grasps the enlarged testis with the hand of the same side, *i.e:* the right testis with his right hand and vice versa. The swelling is firmly grasped to render the skin tense and the penis rotated out of the way with the thumb. The light is placed on the brighter side, the observer being on the darker side to get the full advantage of contrast. Care in making this examination will save many errors in diagnosis. Enlargement of the epididymis is felt above, behind, and at the back of the testis, the whole organ having the effect of being relatively flattened from side to side. Enlargement of the lumbar glands and examination of the rectum for deposits in the prostrate and vesiculæ should never be omitted, but in the more obscure cases exploration is needed before a diagnosis can be made.

CONGENITAL DEFECTS. These concern the development and descent of the testis ; failure of descent is usually associated with imperfect development and probably is dependent on the same causes ; very rarely the testis is absent or the vas deferens defective.

ABNORMALITIES IN THE DESCENT OF THE TESTIS. These may be divided into (1) incomplete descent (undescended testis) ; (2) descent into some abnormal position (ectopic testis).

(1) The descent of the testis into the scrotum should take place during the last month of fœtal life, but if not present at birth descent is possible up to the age of one or two years.

Cases of undescended testes fall into two groups :

(a) The abdominal or iliac type, the testis lying somewhere between its place of origin and the internal inguinal ring.

(b) The inguinal type, in which the testis lies in the inguinal canal.

In most cases the mesorchium is long and loose, the epididymis is partially unravelled and not closely applied to the testis, which is often inverted.

(2) Ectopic testis is presumably due to the organ being pulled out of position by strands of the gubernaculum which arise from the pubis, perineum, or about the crural canal. The malplaced testis is found accordingly in the following positions :

(a) The perineal, when it passes back between the thigh and scrotum to rest in the perineum in front of the anus.

(b) The crural, when it lies in the thigh close to the saphenous opening.

(c) The pubic or penile, when it lies on the pubis at the root of the penis. In all forms of undescended and ectopic testis the scrotum on the affected side is undeveloped and inguinal herniæ are common, especially in the undescended inguinal form, owing to failure of closure on the part of the processus vaginalis. Since the scrotum is undeveloped such a hernial sac is often in the abdominal wall, *i.e.* of the interstitial variety, or this may exist in conjunction with a scrotal sac (*see* pp. 280–282).

RESULTS OF IMPROPER DESCENT OF THE TESTIS. (a) Imperfect development of the testis is usual, though this is to be regarded rather as a cause or due to the same cause as the non-descent, than as a sequel. As such testes seldom have any function, they may, if single, be sacrificed without any qualms on the part of the surgeon.

(b) The testis is more liable to be injured than is normal ; if in the canal, by the pressure of trusses or of the contracting abdominal muscles ; if perineal or crural, by external violence such as sitting or riding, as the organ can less readily slip away from injury than when in its normal situation ; hence attacks of traumatic orchitis, of varying severity, are common.

(c) Owing to the long, loose mesorchium, torsion of the testis is likely to result, particularly in the partially descended form.

(d) Malignant disease is more liable to occur in the imperfectly descended testis ; one case in every five of malignant disease of the testis has been found to occur in the undescended organ. Repeated injuries or maldevelopment, or the two combined, may be responsible for such changes.

(e) The proximity of the undescended organ to the peritoneum renders all infective conditions of the testis more serious than when it is normally placed.

Treatment. (1) *Undescended Testis.* As there is some chance of the organ, when in the canal, coming down during the first two years or so of life, these cases should not be operated on too young, but if possible the testis pushed down out of the canal and a truss fitted above, if hernia be present. Where a hernia is present and a truss only presses on the testis, the latter should not be employed but operative treatment is indicated after three or four years. The processus vaginalis is dissected

up and tied off at the internal ring, the latter is closed as in other hernia operations. All the structures of the cord except the vas and its vessels are then divided, and the testis brought down into the scrotum; such free division will usually render this possible and without endangering the testis (Bevan). The testis is kept down in the scrotum for a few days by a temporary suture which passes through the lower part of the scrotum into the skin of the thigh. To be successful there must be no tension when the testis is brought down, or this will drag up the latter in front of the pubis, where it is painful and liable to injury; besides which any tension on the cord tends to pull down a new process of peritoneum into the canal, and so cause another hernia to form. Where such free division of the tissues does not permit of easy descent of the testis the latter may be removed, if the other testis is normal, since its function is problematical. Where both testes are undescended it seems reasonable, if they cannot be brought down, to push them back entirely into the abdominal cavity after closing the processus vaginalis, and then close the canal, since their internal secretion may be of some service.

(2) *Ectopic Testis.* Where the organ is in the perineal or crural position it should be replaced in the scrotum out of harm's way, but if atrophic and the patient past puberty, with a second testis of respectable size, it is well to remove what may be a source of trouble later. In fact, where there is maldescent of the testis, on one side, the accompanying hernia is far more important, and attention should be directed to curing this without paying too much attention to the testis.

Fig. 217. Torsion of an improperly descended testis. The organ is upside down (a hydatid of Morgagni is seen at the bottom) and has a long loose mesorchium, in which the vas is seen.

TORSION OF THE TESTIS. This always occurs in an imperfectly descended testis owing to its long slack mesorchium. The condition is akin to volvulus of the intestine; an elongated viscus attached by a narrow pedicle can be twisted by slight force about its attachment, though the determining force in any case is often uncertain. The results of such twisting are that the blood-supply is gradually cut off. First the venous return is obstructed, causing venous congestion and great œdema; later the arterial supply is cut off, causing anæmic necrosis. If infection do not result, the end is fibrosis and atrophy, but owing to the vicinity of the intestines which contain bacteria, infection and gangrene may occur.

Signs. These closely resemble those of strangulated hernia. The onset is sudden with acute pain, and a tense tender lump is found in the groin with no impulse on coughing. In the early stages the testis may be felt at the bottom of the swelling, and the congested turgid epididymis above, since these testes are usually inverted. Vomiting and fever are

usual, but constipation, if present, is not absolute, as in most cases of strangulated hernia.

Diagnosis. This is made from strangulated hernia by the absence of a testis on the affected side, by the early fever, and by absence of intestinal obstruction and swelling of the abdomen. Strangulation may, however, take place in a hernia associated with undescended testis, and intestinal obstruction is not always well marked in early cases of strangulated hernia. Hence, though some cases pass on to atrophy and fibrosis of the testis with no other ill effects, there can be no doubt that the right line of treatment is operative, except in those uncommon cases where the testis is in the scrotum, can be felt as such, and the mesorchium untwisted.

Treatment. Early operation is indicated lest by mistake a strangulated hernia be left over long. The testis is exposed by an incision as for herniotomy and the mesorchium untwisted. In most cases the organ should be removed, but under special conditions, *e.g.* where the other testis is atrophic and the twisted organ of fair development, it is worth suturing the mesorchium to prevent any further twisting.

INJURIES OF THE SCROTUM, TESTES, AND VAS

CONTUSIONS OF THE SCROTUM. These may give rise to great extravasation of blood, the scrotum being blackened and swelling, perhaps to the size of a cocoanut. This is to be distinguished from bleeding into the tunica vaginalis (hæmatocœle) and rupture of the urethra. From the former the greater diffuseness of the swelling, which does not form an ovoid tumour, the fact that both testes are obscured to palpation, while in the case of a hæmatocœle only the one on the affected side will disappear, and that the skin shows bruising where the effusion is diffuse, will distinguish. In extravasation, from a ruptured urethra the scrotum is also black and distended, but in addition there is bleeding from the urethra and retention of urine.

Treatment. Rest in bed, the part being raised on a cushion and dressed with cooling lotion at first, later with fomentations, will promote rapid absorption. Should suppuration occur the swelling is opened and drained.

VAGINAL HÆMATOCŒLE. Extravasation of blood into the tunica vaginalis may be the result of blows or crushes of the testis or follow after tapping a hydrocœle, either because the testis or a vessel is punctured or from a vessel giving way spontaneously from the diminished pressure inside the sac (this last is problematical). Bleeding may occur apart from injury owing to disease of the vessels or inflammation of the tunica.

Signs. After injury the onset is sudden, but when arising spontaneously is likely to be insidious. There is a smooth ovoid swelling in the scrotum mapping out the distended tunica vaginalis, fluctuating at first, but without the translucency of a hydrocœle ; as a rule there is no discoloration of the scrotum unless the latter has been bruised as well. As the blood clots the swelling becomes smaller and firmer, the fibrin being deposited in layers on the testis and wall of the sac like that inside an aneurysm. Later the

clot breaks down in parts and fibroses elsewhere, so that the swelling becomes irregular ; suppuration may follow, and calcification is common in old standing hæmatocœles.

Diagnosis. The cord being normal and the inguinal canal free shows that the condition is not a hernia ; from hydrocœle the absence of translucency will distinguish. From a new growth of the testis diagnosis on physical signs alone may be impossible, but the history will often be suggestive. A swelling of the above nature coming on shortly after an injury, and being larger at first, tending later to contract rather than to grow, and if seen after some months the fact that though irregular it is not growing, while the lumbar glands and cord are not involved, point to a hæmatocœle. In these cases, however, early exploration is sound policy, since operation is the best treatment for a hæmatocœle, while if the condition be a new growth early operation is the only hope of cure. Puncture with an aspirating-needle is useless, as in either case blood will be obtained.

Treatment. Expectant treatment is tedious and often ineffectual since the absorbent powers of the tunica vaginalis are small. It is best to expose the sac by incision in the groin and upper scrotum, open the swelling, turn out clots and, if a hydrocœle have been present, remove the greater part of the parietal tunica vaginalis, tie bleeding-points and drain for twenty-four hours, after suturing the skin. Where the condition is of old standing and the testis atrophic or the seat of suppuration, it is as well to remove testis and tunica vaginalis together.

INJURIES OF THE TESTIS. (*a*) The testis may be dislocated under the skin by contusions ; it should be replaced by manipulation.

(*b*) Contusions of the testis cause great pain and shock, while orchitis will often result later. The condition is treated by rest in bed, elevation of the part, and cooling lotions.

(*c*) Wounds of the testis are uncommon except puncture, from uncircumspect tapping of a hydrocœle, leading to orchitis. The treatment is as above ; atrophy may follow.

Incised wounds where not much damage has been done are met by cleansing and suturing the tunica albuginea, and draining the tunica vaginalis for two days. Where there is much damage, laceration or crushing, the organ is best removed.

INJURIES OF THE CORD. Torsion of an undescended testis has been described above (p. 639).

HÆMATOMA AND HÆMATOCŒLE OF THE CORD. These conditions result from injury or surgical interference, such as radical operation for hernia owing to failure to tie vessels after dissecting out the sac. The effusion may be : (1) Diffuse in the tissues of the cord (hæmatoma). (2) Circumscribed, when the bleeding is into a hydrocœle of the cord whether actual or potential, *i.e.* into an unobliterated part of the processus vaginalis.

(1) In the case of a hæmatoma there is a doughy irreducible swelling along the cord, without impulse on coughing and not descending as far as the testis.

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(2) Hæmorrhage into a patent part of the processus vaginalis resembles a hydrocœle of the cord, being a tense, mobile, rounded swelling, irreducible and without impulse on coughing, but not translucent as is a hydrocœle.

Treatment. Where the swelling is small, expectant measures, such as rest and cooling lotions, may be employed, but if large and not readily absorbed the swelling should be opened, the clot turned out, and any hydrocœle sac removed.

INJURIES OF THE VAS. This may be torn by violence or cut at operation ; the latter is the more common cause, the former being a rare accident. Subcutaneous rupture in its scrotal part will produce swelling of the cord, but if torn in the abdomen simply hypogastric pain. In both situations bleeding from the urethra and, later, atrophy of the testis may occur.

Treatment. Where the condition is clear, as when cut at operation, the ends should be united with the finest catgut.

HYDROCŒLE. This term is applied to various cystic conditions found in the scrotum filled with serous fluid or fluid containing spermatozoa ; more rarely chyle is found in these cysts. Several conditions of quite different origin are grouped under this loose heading, following the crude methods of ancient pathology, which regarded all water-cysts as of similar nature. It may be noted that cysts in other places are sometimes called hydrocœles, *e.g.* the cystic hygromas or hydrocœles of the neck. Some hydrocœles are clearly the result of inflammation, others very probably of this nature, while yet others are cysts of new formation or are due to retention. Should a hydrocœle become filled with blood it is called a hæmatocœle.

Anatomically, hydrocœles are divided into : (*a*) Those of the testis ; (*b*) those of the cord.

(*a*) Hydrocœles of the testis are further divided into : (1) Those where the fluid is in the tunica vaginalis (vaginal hydrocœles) ; (2) those where the fluid is connected with the testis or epididymis (encysted hydrocœles).

(*b*) Hydrocœles of the cord occur as (1) encysted hydrocœles, in which the fluid is contained in a patent relic of the processus vaginalis ; (2) diffuse hydrocœles, where the fluid is spread through the substance of the cord.

It should be noted that whereas encysted hydrocœles of the cord are connected with the development of the processus vaginalis those of the testis have no connexion with this structure.

It is more reasonable to consider these cysts in the light of their origin.

(1) Hydrocœles derived from the processus vaginalis. Associated with the descent of the testis there is a protrusion of peritoneum (the processus vaginalis) from the internal ring down to the bottom of the scrotum into which the testis projects. This process should become obliterated between the internal ring and the top of the testis, leaving only the tunica vaginalis ; failure of obliteration of the processus vaginalis may occur in various ways.

(*a*) The processus may remain completely open, thus leaving a sac communicating with the abdomen, through which a congenital vaginal hernia may descend, or which may become filled with fluid, in which case it is known as a " congenital hydrocœle " (Fig. 218 A, *see* pp. 280–281).

(b) The processus may be occluded at its upper end (the internal ring) in which case the tunica vaginalis extends up into the inguinal canal and, if filled with fluid, is known as an " infantile hydrocœle " (Fig. 218 B).

(c) The processus may be occluded at its upper end and again above the testis, the intervening part being patent, or there may be a string of alternately obliterated and patent parts. Collections of fluid in such unobliterated portions are known as "encysted hydrocœles of the cord " (Fig. 218 c).

(d) The upper part of an infantile hydrocœle which extends up the canal may proceed further and bulge into the abdomen, sometimes forming a large swelling there. In this condition of " hydrocele en bissac " there
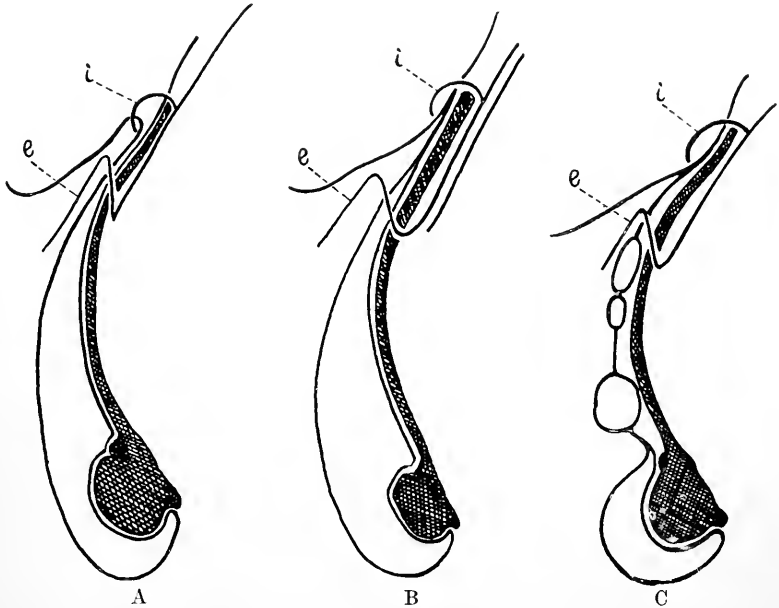
FIG. 218. Varieties of Hydrocœles. i, Internal ring. e, External ring. A, Congenital. B, Infantile. C, Encysted hydrocœle of the cord.

is a fluid cyst in the scrotum communicating through the inguinal canal with a second cyst inside the abdomen, which may be of vast proportions (Fig. 218 D).

(e) A hernial sac may become cut off by adhesions, &c., at its neck, from the abdominal cavity, in which case we have a "hydrocœle of a hernial sac " (Fig. 218 E).

(f) Finally fluid may collect in an otherwise normal tunica vaginalis (common vaginal hydrocœle) (Fig. 218 F).

The occurrence of potential hydrocœles of the processus vaginalis is thus in part explained, but these do not of necessity become filled with fluid ; thus it is fairly common when operating on cases of congenital hernia to find sequestrated parts of the processus vaginalis containing no fluid.

(2) Some hydroceles arise as retention cysts from the blocking of gland tubules; these are found in connexion with the epididymis, the
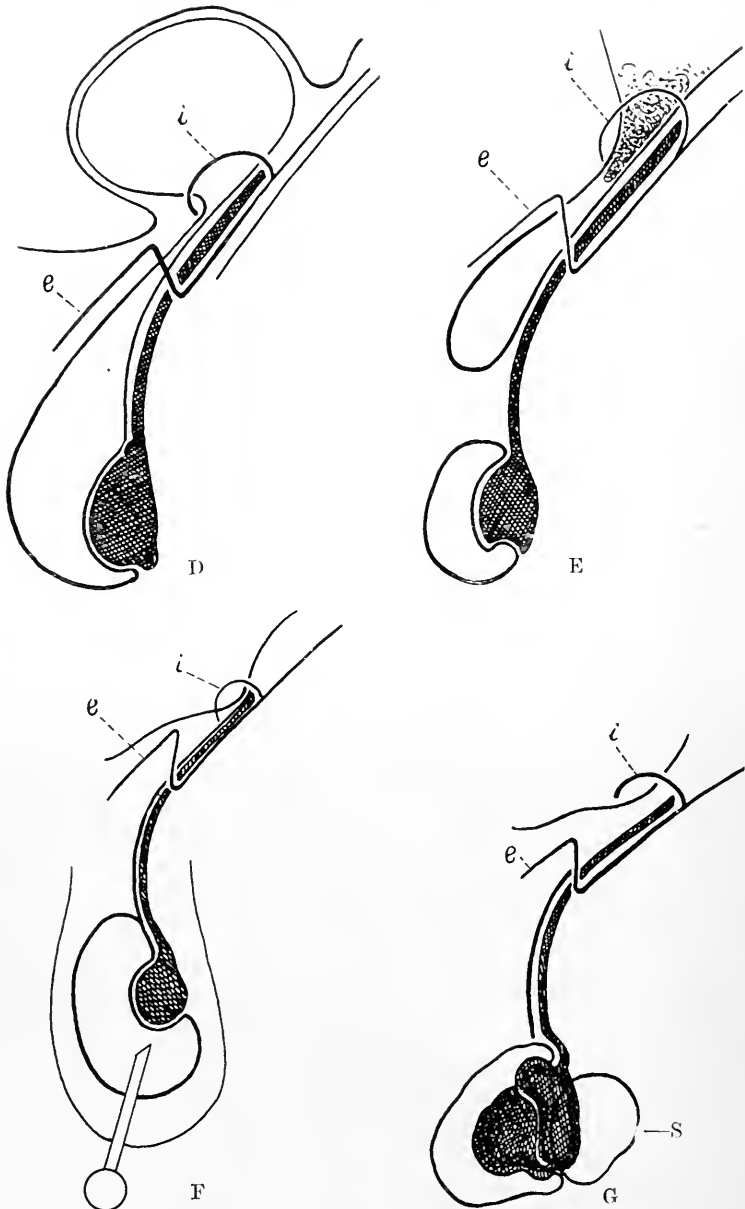
Fig. 218A. Varieties of Hydrocœles. *i*, Internal ring. *e*, External ring. D, Bilocular. E, In a hernial sac. F. Vaginal. G, Encysted hydrocœle of the epididymis or spermatocœle (S).

fluid containing spermatozoa, whence the name " spermatocœles " or " encysted hydrocœles of the epididymis " (Fig. 218 G).

(3) Cysts from dilatation of the lymph-spaces are found in the cord

and testis, but are rare. It will be seen that certain hydrocœles of the testis, viz. the congenital and infantile forms, may equally well be named hydrocœles of the cord, since they extend into the latter. With the exception of spermatocœles, hydrocœles derived from the processus vaginalis are the only sort of practical importance.

A. Signs and Treatment of Hydrocœles due to Mal-development of the Processus Vaginalis. These are usually found in infants and children, less often coming into prominence in young adult or later life.

(a) The "congenital hydrocœle" is found in infants as a fluctuating translucent swelling, which comes down and surrounds the testis, gives an impulse on coughing, is reducible without a gurgle, and is not retained by a truss; the last two points separate the condition from congenital hernia.

Treatment. In quite young infants the pressure of a truss may assist in the closure of the processus vaginalis and prevent the descent of viscera, but where the condition persists after a few months an operation should be performed as for congenital hernia, the upper part of the sac being removed and tied off at the internal ring

(b) The signs of an infantile hydrocœle closely resemble those of the common vaginal form, viz. a tense, fluctuating, translucent, scrotal swelling, irreducible and without impulse on coughing; the swelling and fluctuation, however, extend up along the cord into the inguinal canal.

Treatment. Aspiration may be tried at first, but if this fail after a few attempts the parietal part of the sac should be excised as in the cure of the vaginal type.

(c) In the bilocular hydrocœle or form " en bissac " there is a fluctuating translucent swelling in the scrotum with an impulse on coughing connected with a fluctuating abdominal or iliac swelling, while fluctuation can be obtained between the two loculi of the cyst. The scrotal portion can often be reduced to some degree into the abdominal portion, but without any gurgle, and this renders the abdominal cyst more prominent.

Treatment. The sac should be exposed by an inguinal incision as for a radical operation for hernia, the abdominal part is dissected out completely, and removed with the scrotal loculus close to the testis; the internal ring is closed as in a hernia operation, and, as considerable oozing is probable, the wound is drained for two days.

(d) An encysted hydrocœle of the cord, as has been mentioned, is a patent part of the processus vaginalis, distended with fluid.

Signs. A tense, ovoid body is found along the cord above the testis, and this usually feels more dense than the testis itself, though fluctuation can be made out; its translucency clinches the diagnosis. In some instances the cyst can be moved by pulling down the testis. A hydrocœle of the cord high up in the inguinal canal closely resembles a hernia, but is equally tense whether the patient coughs or not; the impulse on coughing is not expansile, but only downward, and further palpation will show that it forms a separate mass not merging with the abdominal

contents on reduction; from a strangulated hernia it is distinguished by the absence of tenderness, its mobility on coughing, and the absence of any signs of intestinal obstruction.

Treatment. Where these cysts recur after tapping they should be dissected completely out of the cord.

(e) *Hydrocœle of a Hernial Sac.* The sac, whether congenital or acquired, becomes sealed off at its neck from inflammation caused by wearing a truss, or more often, in our experience, from a piece of omentum becoming adherent in the neck and firmly corking the sac. The pressure exerted by the neck on the omentum causes œdema of the latter, and the fluid thus exuded fills the sac and forms a hydrocœle.

Signs. The physical appearance is similar to an infantile hydrocœle when the sac reaches the testis, *i.e.* is of the congenital vaginal type ; where the sac is of the funicular variety the cyst will closely resemble an encysted hydrocœle of the cord : a previous history of reducibility will suggest the real origin of the cyst. We have found the form due to omental plugging more commonly in femoral than inguinal sacs.

Treatment. The sac is excised and tied off at the internal ring, which is closed as in operations for the radical cure of hernia.

B. Hydrocœles in an otherwise Normal Tunica Vaginalis (Vaginal Hydrocœle). Vaginal hydrocœles may be divided into acute and chronic, and it is to the latter that the term is more often applied.

(1) *Acute or symptomatic hydrocœle* is associated with acute or sub-acute inflammation of the testis or epididymis whether of traumatic, gonorrhœal, tuberculous, or syphilitic origin ; it is most usual and of larger amount with tubercle of the epididymis than with the other conditions, but often the amount of fluid is small and not easily appreciated.

Signs. An ovoid, more or less tender swelling occupies the place of the testis, over which the skin is red in the more acute conditions and which is translucent. It may be possible to make out enlargement of the testis or epididymis, but this is often masked by the exudate in the tunica vaginalis.

Treatment. If of appreciable size these hydrocœles should be tapped, not so much for treatment as to investigate the condition of the testis. Then from a consideration of the size of the testis proper or epididymis and their consistency, and from signs elsewhere in the prostate, vesiculæ, bladder, lung, &c., a diagnosis is made of tubercle, gonorrhœa, syphilis, and the appropriate treatment instituted ; hence these hydrocœles are to be regarded as symptomatic.

(2) *The Chronic or Common Vaginal Hydrocœle.* These collections of fluid in the tunica vaginalis, arising apart from congenital defects, are often due to inflammation or degeneration and consequent fibrosis of the tunica, which may be of specific nature, *e.g.* syphilitic ; in the majority of cases the underlying cause is unknown. There is often fibrosis of the testis, especially of the tunica albuginea, the organ being shrunken. As to the thickening of the tunica vaginalis, it is uncertain how much this is the cause of the

hydrocœle and how much is due to the irritation of the exudate. These hydrocœles are most common in middle-aged and elderly persons, which is in favour of their origin being due to degeneration.

The immediate cause seems to be a block of the lymphatics of the tunica vaginalis with fibrous tissue so that the absorption is interfered with, the secretion of the serous membrane being no longer absorbed as usual ; pressure on the veins and lymphatic of the cord, as after too efficient closing of the inguinal canal, in operations for hernia, is a definite cause in some instances. The fluid is clear, straw-coloured, and of specific gravity about 1025, containing much albumen. The cyst wall is thin at first, but later may be as much as half an inch thick and of cartilaginous consistency.

Signs. An ovoid or pear-shaped, fluctuating, and translucent swelling occupies the scrotum, the cord above being normal except in those cases where the processus vaginalis has remained unobliterated towards the inguinal canal, as in the bilocular and infantile forms which are sometimes found later in life. In the bilocular form there will be an impulse on coughing, which is not present in the ordinary hydrocœle. The testis may sometimes be felt as a more solid part at the back of the ovoid swelling, besides throwing a shadow when translucency is estimated. Where the wall is very thick translucency may be absent ; in some instances translucency will be noted when examining herniæ of infants, owing to the thinness of the gut. When the hydrocœle is very large, the skin of the penis and scrotum are dragged down by the size and weight of the swelling, so that the urethral meatus opens at the bottom of a cavity, which makes micturition very awkward.

Treatment. Temporary and, very occasionally, permanent relief may be obtained by tapping the cyst with a trochar and withdrawing the fluid. As this is a simple operation occupying but a few minutes and practically painless, many patients prefer tapping, if it has not to be repeated more than once a quarter, to the loss of time involved by more radical measures.

To *tap a hydrocœle* the position of the testis is first ascertained by palpation and transillumination, since, though usually behind, it may occasionally be in front, and if tapped by accident will be followed by orchitis. The scrotum is then rendered aseptic and a fine trochar is selected, the swelling grasped with the left hand so as to make the scrotal wall tense, and the trochar plunged in, where the testis is not, and where there are no obvious veins. The instrument is only pushed through the coats of the hydrocœle, as if thrust far in it may pierce the testis. The fluid is drained off, the puncture sealed with collodion, and the patient wears a suspender.

Accidents. Should a vein be punctured, a hæmatocœle is likely to follow, recognized by rapid return of the swelling within a few days, but without translucency. A radical operation, as described below, is then indicated. Should the testis be injured orchitis may follow, indicated by a painful and tender swelling of the testis, for which the patient should be confined to bed, the testis raised on cushions, and cooling lotions applied.

Of more radical measures the following are useful : Excision of part of the sac ; eversion of the sac ; and injection of pure carbolic.

(1) *Excision* is best suited to large thick-walled hydroceles of old standing. The hydrocele is exposed by incision through the upper part of the scrotum, the sac opened, and the fluid allowed to escape. The wall of the sac is dissected from its surroundings, care being taken not to injure the vas in the upper part of the dissection. The sac is cut away all round about three-quarters of an inch from its reflection on to the testis. All bleeding-points are tied or twisted and the wound closed with drainage for forty-eight hours and bandaged firmly up on to the abdomen, as oozing is very common and a collection of blood-clot likely to prove troublesome.

(2) For the smaller cysts with thin walls *eversion* is a simple and efficient treatment. The hydrocele is exposed and opened, letting out the fluid, the testis is brought out of the opening, and the aperture in the sac closed with a few sutures round the cord to prevent the testis slipping back again. The wound is then closed, after pushing the testis back under the outer coverings of the scrotum. In this way the tunica vaginalis is turned inside out and its secretion is readily absorbed by the loose tissues of the scrotum.

FIG. 219. Operations for cure of hydrocele. I, Entering the sac. II, The same in section. III, Resecting frontal sac. IV. The same in section.

(3) *Injection of pure carbolic* is useful where the patient does not want to lose the ten days needed before an operative wound is healed. After tapping a hydrocele in the ordinary manner, half a drachm of liquefied pure carbolic acid is injected down the trochar, which is then removed and the scrotum massaged to force the acid around the testis. The patient lies up for two days and then wears a suspender for a while. The cavity of the tunica vaginalis should be obliterated and the hydrocele ceases to recur. Cure is less certain than by the more lengthy procedure of excision. Injection of strong solution of iodine has the same effect, but is very painful and therefore to be avoided.

C. Hydrocœles which are Retention Cysts. *Spermatocœles or Encysted Hydrocœles of the Epididymis.* These cysts are lined with cubical or flattened epithelium and are filled with opalescent fluid containing spermatozoa, which often exhibit lively movements. They probably arise from some blocking of the vasa efferentia. The fact that the spermatozoa are alive and that these hydrocœles most often arise in middle age is against their being of congenital origin. They arise in the globus major of the epididymis and may be compared with involution cysts of the breast.

Signs. A chronic, painless, cystic, translucent swelling is found, closely connected with the epididymis which is seldom more than twice the size of the testis, though occasionally as large as a fist. The cord is free from enlargement. In the less common instances, where no spermatozoa are present, such cysts may be developments of Kobelt's tubes, or other embryonic relics of the Wolffian body and akin to parovarian cysts in the female.

Diagnosis. Spermatocœles are distinguished from hydrocœles of the cord by their very intimate connexion with the epididymis, and, after tapping, by the opalescence of the fluid and presence of spermatozoa ; from vaginal hydrocœles by the swelling not surrounding the body of the testis as do the latter.

Treatment. These cysts seldom cause any trouble, but if obnoxious from their size, or if in the way, they may be tapped : if recurrence takes place, as is likely, they are removed by dissection.

D. Hydrocœles of Obscure Origin, in some Instances being Dilated Lymph Spaces. These are all rare and of small account.

(*a*) Encysted hydrocœle of the testis is a cystic swelling seldom attaining great size, formed of a collection of serous fluid between the tunica albuginea and vaginalis.

(*b*) *Diffuse Hydrocœle of the Cord.* This was described by Pott, which is its chief claim to recognition as it has seldom been found since. The affection consists of a diffuse swelling of the cord which is sometimes an passive or active œdema, which latter is better described as " funiculitis," while diffuse lympangeiomas or diffuse tumours of the Wolffian duct sometimes occur.

AFFECTIONS OF THE SPERMATIC CORD

Inflammation. Funiculitis. (1) A tropical, endemic form is described, due to infection with the filaria worm, which causes œdema and local abscess formation.

(2) Acute funiculitis may follow metastatically from infection else-where, thus in one instance we have seen this condition follow the resection of a large amount of gangrenous gut in a boy of twelve ; the condition may arise spontaneously, probably as a B. coli infection, from the intestine, as in some, otherwise obscure, cases of acute orchitis.

Signs. A tender swelling forms in the inguinal region which later becomes red, there is no impulse on coughing, and it may be difficult to

distinguish from a strangulated hernia except for the absence of intestinal obstruction and the presence of fever.

Treatment. The cord should be explored by a free incision along the course of the swelling and abscesses and areas of cellulitis opened and drained.

VARICOCŒLE OR VARIX OF THE PAMPINIFORM PLEXUS. This condition is an exaggeration of the normal tortuosity of the spermatic veins, chiefly due to congenital causes, less often to obstruction of the veins higher up, *e.g.* from renal tumours, and thus the varicocœle of adolescents is to be distinguished from the symptomatic varicocœle of middle age.

Enlargement of the pampiniform plexus is found in varying degrees, and in most instances can hardly be regarded as pathological, but simply as a rather wide variation from the normal.

Varicocœle is more common on the left side, and various causes are held responsible for this, such as : (*a*) The sigmoid flexure crosses the left spermatic veins and may compress them. (*b*) The left spermatic veins open into the left renal vein at an angle and unguarded by a valve. (*c*) The left testis hangs the lower, and hence there is more pressure inside the veins on that side. A more likely cause is the earlier descent of the left testis, the inguinal canal closing earlier on the left and perhaps more completely, and so possibly constricting the structures of the cord. This is borne out by the greater infrequency of congenital hernia on the left side, and that varicocœles sometimes result after operations for hernia, where the inguinal canal has been closed with too great stringency. Relaxation of the scrotal tone from an insufficient dartos or living in hot climates may have some effect on the condition.

In most instances the condition is of no importance, but there is always some possibility of prolonged standing, marching, &c., causing some aching in the distended veins, and the presence of a varicocœle affords an excellent opportunity for malingering, as the patient has something to show which may be painful ; hence the zeal with which examiners of army candidates refer for operation varicocœles of even microscopic size. The larger varicocœles sometimes lead to, or are at all events associated with, atrophy of the testis.

Symptoms and Signs. In most instances there are no symptoms, but the aching described may be noted. Examination shows a swelling in the scrotum along the cord, the convoluted and distended veins giving a sensation when handled, which has been aptly compared with that given by a bag of worms.

There is a distinct impulse on coughing, while on assuming the recumbent position the swelling largely disappears, without a gurgle, to refill again as the patient stands, even if a finger be kept on the external ring ; this last point distinguishes a varicocœle from an omental hernia if the worm-like outline be not sufficient. The condition is first noted about adolescence and the veins shrink at about thirty ; fatty degeneration of the testis, with atrophy, is sometimes associated with varicocœle.

Treatment. Most cases require no treatment except general tonics, cold bathing of the scrotum, the bowels open, and reasonable amount of exercise. Where any pain is felt, a suspender should be worn and the patient frankly told that there is not the least danger of impotence resulting, since this fear often leads the subjects of varicocœle to fall into the hands of quacks.

Operative treatment is only indicated where the patient is a candidate for one of the public services (to remove possibilities of malingering) or where the varicocœle is very large and painful in spite of the above measures, or where a suspender is a source of annoyance.

Operation. The cord is exposed by an inch and a half oblique incision over the external ring, *i.e.* somewhat lower than for a hernia operation. The cord is hooked up and the three layers of spermatic fascia opened along the incision, disclosing the spermatic veins, which are freed by blunt dissection from the other structures leaving the vas with its vessels and the spermatic artery intact. The spermatic veins are dissected downward till the testis is nearly pulled into the wound and ligatures applied around the veins at the upper and lower extremities of the part exposed. The intervening part (about two inches and a half) is excised and the cut ends sutured together, so that the testis is slung at a higher level than before. Bleeding-points are secured and the wound closed without drainage, the scrotum being bandaged up on the abdominal wall. The patient can get up in ten days. Retention of urine is a common after result, and may need relief with a catheter. Some surgeons remove the spermatic artery as well ; this seems unnecessary.

Symptomatic Varicocœle. The sudden development of a varicocœle usually on the right side, in a middle-aged person is highly suggestive of malignant disease of the kidney on that side, which should be thoroughly investigated as to size and function. The treatment is directed to the kidney, if diseased.

TUMOURS OF THE SPERMATIC CORD. Mention has been made of conditions described as " diffuse hydrocœles " of the cord, which are lymphangeiomas.

Allied to these is the rare condition lymphocœle, where a mass of dilated lymphatics present the appearance of a varicocœle and should be treated by excision.

Lipoma is the only tumour at all common in the cord. This takes origin in the extraperitoneal fat and descends the inguinal canal, sometimes dragging a peritoneal sac after it. For this reason it is an important cause of hernia and has much in common with the extraperitoneal fatty hernia occurring through apertures in the linea alba. These lipomas appear as doubtfully fluctuating swellings, coming down the inguinal canal with no impulse on coughing (unless a peritoneal sac be present as well) and irreducible. The condition closely resembles an irreducible omental hernia, and exact diagnosis is difficult, especially where there is a hernia as well.

Treatment. Since a hernia is likely to result, the lipoma should be exposed by opening the inguinal canal, as when operating on a hernia, and removed by dissection ; examination is made for any hernial sac and this removed, the canal is closed as in a radical operation for hernia.

AFFECTIONS OF THE TESTIS AND EPIDIDYMIS

INFLAMMATIONS. Inflammation originates most usually in the epididymis, less often in the body of the testis, the conditions being known as *epididymitis* and *orchitis* respectively, but the process is seldom confined entirely to one part of the organ and, when examined carefully, is usually found to be an epididymo-orchitis, though the most advanced changes are usually present in the portion first affected, which varies with the cause and the manner of access of the infective agent, since in most instances infection is the main underlying cause. The process may be acute or chronic.

ACUTE ORCHITIS. As regards causation, injuries, whether crushes, blows, or punctures (from tapping a hydrocœle) fairly often cause orchitis ; it is also found in the course of general infections, especially mumps and occasionally in enteric fever ; in the former case orchitis may be found apart from a parotid lesion. Orchitis may result by metastasis from some suppurative focus, though these are not always to be found, and gout and rheumatism are held responsible but with little justification. Acute orchitis is not uncommon in boys, and may be suppurative ; in these subjects the condition is often due to infection with the colon bacillus, which may attain entrance to the blood stream in the course of coli bacilluria. Orchitis spreading from the epididymis is less common.

Signs. The testis rapidly becomes large, painful, and very tender, the skin over the organ becomes red and œdematous, while an acute hydrocœle of small dimensions is common. It may be possible to ascertain by palpation that the swelling involves the body only, the epididymis being of normal size stretched over the back of the distended testis ; fever is usual. Suppuration and abscess formation leading to fistulæ and " fungus testis " are not usual, but atrophy is a common ending in consequence of the seminiferous tubules being strangled by the resulting fibrous tissue.

ACUTE EPIDIDYMITIS. This is commonly consecutive to infection of the posterior urethra, which travels *via* the lymphatics of the vas. The gonococcus is the most frequent cause, the condition arising at any time after the first three weeks of infection ; other infections of the deep urethra due to stricture, prostatic obstruction, an impacted calculus, or instrumentation may cause epididymitis, but less often than the gonoccocus.

Signs. The patient experiences pain in the groin, hypogastrium and testis, followed by swelling of the latter, the onset being sudden. On examination the skin of the scrotum is red and œdematous in the more acute cases, while on palpation the enlargement is, at any rate at first, found to be confined to the epididymis, especially the lower pole (globus minor). The enlarged epididymis is felt as a large crescentic elongate

mass, surrounding the body of the testis on its upper, posterior and lower aspects, the testis as a whole feeling as if flattened sideways. An acute hydrocœle is common, and the cord and vas are thickened and tender ; some fever is usual. Suppuration is more common than in orchitis, but does not often result. Consecutive atrophy of the testis is a common result, and where both sides are affected there will often be an absence of spermatozoa in the seminal emission, and the patient loses his procreative power, though still potent.

Diagnosis. In some instances tubercle and more rarely gummata develop as acute swellings, rapidly breaking down with formation of sinuses and perhaps fungation. The absence of gleet, stri_ture, or instrumentation, and the presence of nodes in the prostate will help to distinguish the former condition. A positive Wasserman reaction, other signs of syphilis, and the tough yellow slough disclosed as the swelling bursts, will prove the presence of the latter disease. The student must beware of considering all cases of acute epididymitis as being of gonorrhœal origin.

Treatment. Both orchitis and epididymitis are treated on similar lines. The patient is confined to bed with the testis raised on a small cushion, cooling applications being applied in the milder and earlier cases, fomentations in the more aggravated conditions. The bowels are kept freely open and hot hip baths help to relieve the pain. Where the hydrocœle is of any size it should be emptied with an aspirating needle, and where suppuration occurs, as shown by the skin turning purple, and fluctuation being present, the abscess is freely opened and drained. In the ultra-acute cases of a septicæmic nature the swollen organ should be opened early and drained. Operative interference is advocated, especially by American surgeons, even in non-suppurative gonorrhœal cases, the tunica vaginalis being opened and washed out with perchloride of mercury solution (1–2000) and multiple punctures are made in the enlarged epididymis, any small abscess being drained for a few days. It is stated that absorption is more rapid under this regime, but it is uncertain whether the vasa efferentia are restored to their normal potency any better than by conservative measures. Later, as the acute condition subsides, the testis is supported with a suspender, and if this thickening persists the organ may be strapped over Scott's dressing, and iodides given internally, which will assist in promoting resolution.

Where the original cause is situated in the deep urethra the gleet, stricture, or enlarged prostate should be treated after the acute stage has passed off.

Chronic Inflammations of the Testis and Epididymis. These are of urethral, tuberculous, and syphilitic origin. Chronic inflammations of the testis and epididymis, especially of the latter, apart from tubercle and syphilis, are usually consecutive to posterior urethritis or gleet, though injuries and strains may account for some instances. In the course of a gleet a node may appear in the globus minor of the epididymis, which is but slightly painful and often unnoticed by the patient, and which

later forms a fibrous mass ; similar nodes may persist after an attack of acute epididymitis. This is to be distinguished from the chronic epididymitis of secondary syphilis by the node being in the globus minor and not in the globus major, as in the latter.

Treatment. The posterior urethritis is treated by irrigations, instillations, and prostatic massage, while pressure is exerted on the testicular enlargement with strapping or a Martin's rubber bandage, and iodides are given internally.

TUBERCULOSIS OF THE TESTIS. This is essentially a disease of young adults and is probably always secondary to tuberculous lesions in other parts of the body, but may be the initial lesion in the genito-urinary tract as far as can be ascertained during life.

There are two main paths of infection :

(1) Hæmatogenous, the bacilli being brought by the blood either from some other definitely tuberculous focus, as in the lung or a bronchial gland, or, having entered the body through some portal such as the tonsil, the epididymis may be the first resting-place.

(2) The disease may spread by the lymphatics from neighbouring parts, *e.g.* from the prostate. At present it is most generally held that the spread is rather from the testis to the prostate than in the reverse direction, though some (Walker, Keyes) make out a good case for primary prostatic infection. The former observer states that the origin is more common in the globus minor than the globus major, and in the latter than in the corpus Highmori, which suggests an ascending spread from the prostate ; the more general view is that tubercle starts in the globus major.

Injury and other inflammation (*e.g.* gonorrhœal) of the testis may predispose to tubercle, but of this there is little evidence.

Pathology. The disease commences, as a rule, in the globus major, in the form of grey tubercles and thence spreads as caseating areas to the rest of the epididymis and later to the testis, the latter however often remaining free for some time. The spread is then along the lymphatics of the vas to the base of the bladder prostate and vesiculæ seminales. The cold abscesses which result from the caseation become adherent to the skin of the scrotum and burst, leaving sinuses through which a mixture of testicular tissue and granulations may fungate, giving rise to one of the forms of " fungus testis." General dissemination may occur.

Signs and Symptoms. Slowly and painlessly a node develops in the globus major, usually on one side ; in less common instances the onset is acute, as in gonorrhœal epididymitis, but when the acute stage has passed instead of resolving, the epididymis breaks down into cheesy pus. In the usual chronic form other nodules appear in the body and tail of the epididymis, which join with the original focus till the whole epididymis forms an enlarged, hard, craggy mass encircling the posterior part of the testis ; a small hydrocœle is common. Next, the body of the testis enlarges and nodules are felt along the vas, so that it feels " beaded " ; still later nodules may be felt in the prostate and rectum (some maintain that there are

always signs in the prostate once the epididymis is affected). Except in the acute cases, pain is slight and testicular sensation present. The condition may end in healing and fibrosis, or in suppuration and caseation, and with formation of sinuses and fungation. When the base of the bladder is affected frequency of micturition and pus in the urine are marked symptoms.

Diagnosis. From gonorrhœal epididymitis the acute variety may be hard to diagnose at first, on local examination alone, but the onset in the globus major, the rapid breaking down, the suppuration which is rare in the gonorrhœal type, and the absence of urethritis should distinguish.
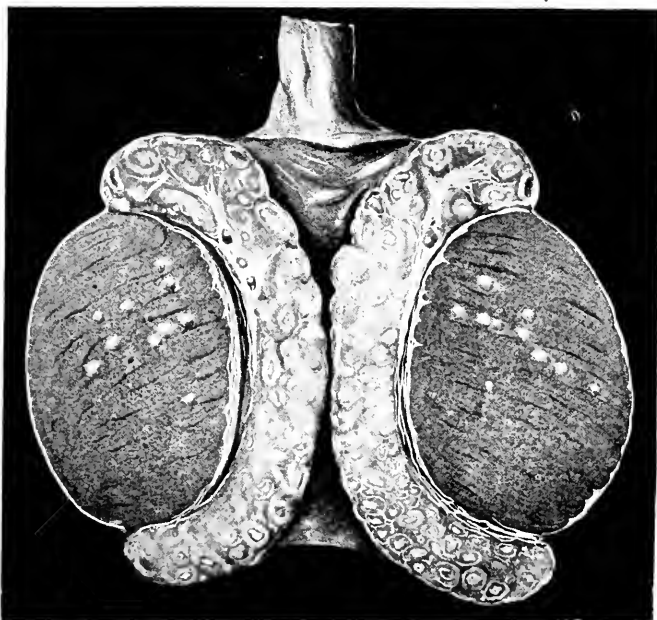
Fig. 220. Tuberculosis of the testis (bisected). The epididymis is filled with mass of tuberculous material caseating in many places. A few scattered foci are also seen in the body of the testis.

Later bladder signs, nodes in the prostate, and bacilli in the urine, make the matter clear. From syphilitic gummata the early and chief enlargement being of the epididymis, the changes in vas, prostate, and bladder, and absence of serum reaction readily separate. From the epididymitis of secondary syphilis the diagnosis is less easy at first, but the latter is bilateral, and there are signs of generalized syphilis and positive serum reaction, while the syphilitic affection does not break down. New growths are distinguished by their affecting testis and epididymis alike, by enlarging far more rapidly, and by not breaking down into abscesses.

Treatment. Genito-urinary tuberculosis is essentially chronic and difficult to heal completely by hygienic measures, such as good feeding, mountain air, sunshine, cod-liver oil, &c., though these means should be employed if possible ; the lesions have a tendency to recrudescence after

even years of apparent health. Therefore it is best carefully to remove any well localized focus when, for anatomical reasons, this is possible. Where there is a node in the epididymis, the rest of the genito-urinary tract being unaffected, the epididymis should be removed (epididymectomy). Where the body of the testis is affected on one side, especially where sinuses are present, castration should be performed and the vas dissected out as far as possible, tracing it up through the inguinal canal to the pelvic brim. The epididymis is reached by an incision along its outer side, which avoids the vessels.

Where the condition is part of a wide-spread tuberculosis, operative treatment should not be undertaken, without due consideration. Since, however, removal of one large focus of tubercle improves the healing of other inoperable foci, removal of the testis or epididymis should be done in cases complicated by phthisis, where the latter is not so advanced as to render operation dangerous or preclude a reasonable prospect of the wound healing. After the tuberculous focus has been removed the patient should be placed under the best conditions to combat the general infection.

SYPHILIS OF THE TESTIS. This occurs usually in the tertiary stage, but also in the secondary stage, and in the congenital form.

(1) Secondary syphilis of the testis occurs after the infection has lasted about six months, it is bilateral, attacks the globus major, and is of the nature of chronic or subacute epididymitis, the part becoming enlarged and hard. This condition is diagnosed from chronic epididymitis of urethral origin by the absence of posterior urethritis, and the situation in the globus major, from tuberculosis by the presence of recent syphilis, by its being bilateral, and not breaking down.

Treatment is antisyphilitic as for generalized syphilis ; atrophy of the testis may follow.

(2) Tertiary and congenital syphilis of the testis is usually unilateral and consists of a round-celled infiltration of the body of the organ, which proceeds to formation of fibrous tissue. This infiltration appears in two main forms :

(a) " *Syphilitic Sarcocœle.*" The testis is enlarged by infiltration with fibrous tissue of good vitality which later contracts gradually, destroying the tubules of the organ and terminating in atrophy.

(b) In the second form or " *gumma of the testis* " the formation of fibrous tissue is more exuberant, and as a result of its contraction and the accompanying endarteritis, the centre of the mass undergoes anæmic necrosis and a yellow gummatous slough is formed ; there may be one large slough occupying most of the organ or several smaller ones scattered through its substance. The underlying changes in these two forms are similar, viz. formation of fibrous tissue, the differences are from the fate of the fibrous tissue. The sarcocœle is the condition more often found in congenital syphilis. A gumma, as it breaks down, becomes adherent to the skin, which softens and gives way, allowing the extrusion

of the characteristic wash-leather slough, while the granulations may protrude through the aperture as " fungus testis."

Signs and Symptoms. The testis quietly and painlessly becomes enlarged and hard, testicular sensation being lost early. On examination the enlargement is found to involve the body of the organ, the epididymis being stretched over the back of the ovoid mass, which is firm and smooth at
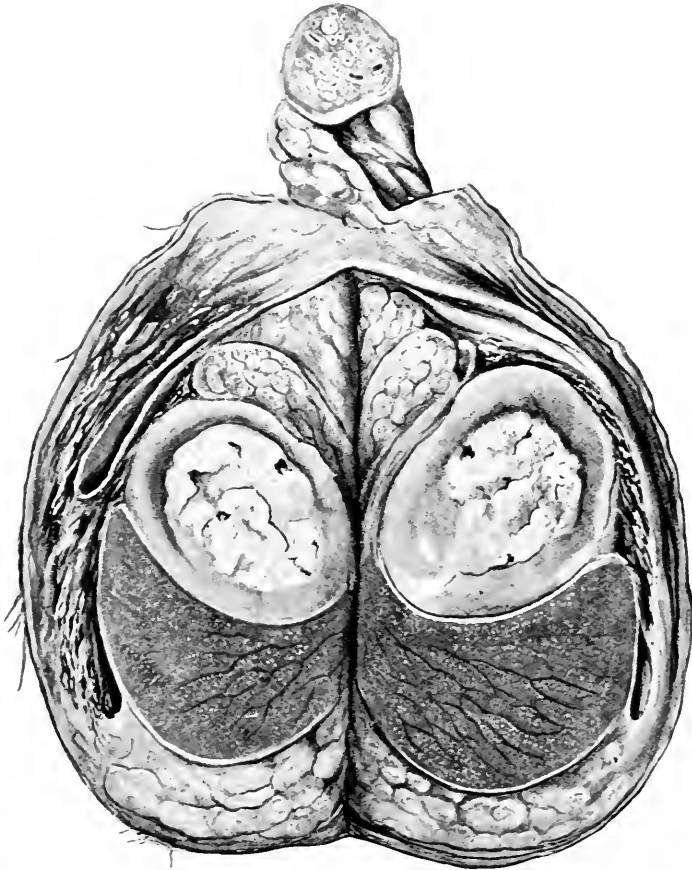
Fig. 221. Tertiary syphilis of the testis (section). A large gumma involves the upper part of the body of the testis ; the epididymis is unaffected.

first. Where breaking down of a gumma takes place, the latter will be felt as a lump which softens and later breaks through the skin showing the usual yellow slough. The absence of pain and loss of testicular sensation are characteristic. The enlargement is seldom greater than a turkey's egg, but occasionally may assume the dimensions of a cocoanut, and when such a mass fungates through the skin it closely resembles a malignant growth.

Diagnosis. From tubercle it is fairly easily separated by the distribution in the body of the organ the freedom of the cord, vas, epididymis,

and prostate, the absence of signs of tubercle elsewhere, and the presence of syphilis as shown by the serum reaction, &c.

From malignant growth, the smaller size, the freedom of the epididymis cord, and absence of enlarged lumbar glands, a Wassermann reaction may help, but rather than delay early treatment, doubtful cases should be explored after ten days if not reacting considerably to large doses of iodides.

Treatment. General antisyphilitic treatment should be given in the form of neosalvarsan, and this should be combined with mercury and, above all, iodides to promote rapid resolution of the gummatous mass. It may be necessary to give very large doses of iodides; in the large fungating condition, if response is slow, the dose may be increased gradually up to sixty or even ninety grains thrice daily. Where a doubtful case has been explored and a gumma is found, the slough should be removed and drug treatment instituted, but if the organ is completely disorganized it may as well be removed at once, as this will hasten healing considerably.

NEW GROWTHS OF THE TESTIS. As might be imagined from the complex structure and development of the testis, new growths of this organ assume very different types of architecture, but agree in the fact that they are usually malignant, a curious fact when one considers the innocence of most ovarian tumours. Neoplasms are more common in improperly descended testes, but in any case growths of the testis are not common. From a structural point of view these tumours may be divided into : (*a*) Those of definitely embryonic origin ; (*b*) hylic tumours, including sarcomas ; (*c*) lepidic tumours or cancers.

(*a*) Of this type are found :

(1) Ordinary dermoid cysts containing sebaceous matter and hair.

(2) Teratomas which are practically very complex sarcomas or mixed tumours containing striped muscle amongst other constituents.

(3) Tumours resembling chorionic epithelioma have been described.

All the above are rare.

(4) Fibrocystic tumours formed of several varieties of cells, epithelial-lined cysts, and cartilage ; it is uncertain whether these are derived from relics of the Wolffian body or are of endothelial or teratomatous origin.

(*b*) Hylic tumours show a considerable variety of structure, all grades being found between slowly growing fibrous and cartilaginous tumours to rapidly advancing round-celled sarcomas.

(1) The innocent mixed-celled tumour (endothelioma). This may consist largely of cartilage or a structure of similar appearance, and is of slow growth at first, but likely as time goes on to take on myxomatous and sarcomatous changes. Cystic developments are sometimes found in which case the tumour closely resembles the already mentioned " fibrocystic tumour " which may be of this nature.

(2) Sarcomas of various type occur, large and small, round- or spindle-celled, as well as structural or angeiosarcomas.

The mixed celled or endotheliomatous type is encapsuled for a long

time before showing signs of dissemination ; the sarcomas spread rapidly from the first.

(c) Of lepidic tumours, cancer is the only form and is the commonest of all testicular tumours ; there is great epithelial proliferation often with a well-marked alveolar arrangement ; these tumours possess no capsule and form metastases early.

Signs. Always painlessly and slowly as a rule, less often rapidly, the whole testis becomes enlarged ; testicular sensation is soon lost. The
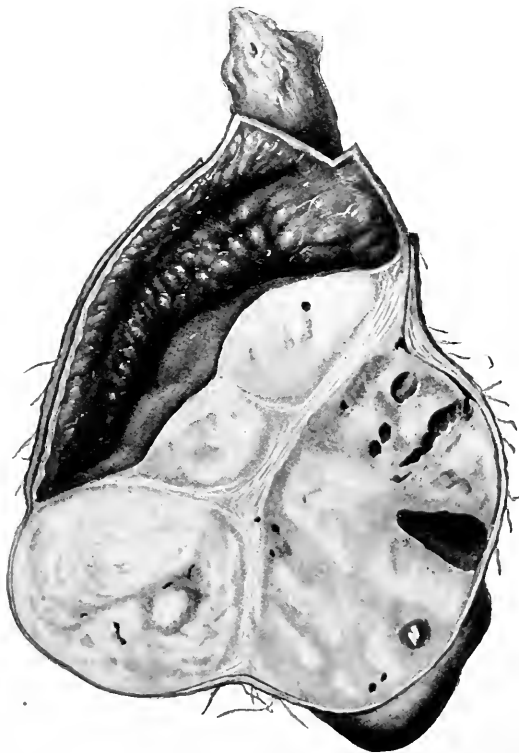
Fig. 222. Sarcoma of the testis (spindle-celled). The growth involves the epididymis and body of the testis is breaking down in parts and invades the skin ; above, the cord and the distended tunica vaginalis are seen.

relatively innocent fibrocystic type may take years to reach the size of an orange, while the more common malignant tumours will attain this size in a few weeks. In the early stages the outline is smooth, but later it becomes irregular for the formation of cysts, in the malignant forms a hæmatocœle is often formed giving the usual smooth ovoid outline. The cord becomes thickened by hypertrophy to compensate for the extra weight it carries, but is only infiltrated later where the growth is cancerous. The lumbar glands are affected early in malignant cases and the pelvic glands are also involved from the spread along the lymphatics of the vas. Dissemination to the liver and lungs soon follows, with great cachexia and early

death. Adherence to and fungation through the skin are uncommon in sarcomas till very late, and when found early suggest inflammatory disease or cancer.

Diagnosis. The two conditions likely to be confused with new growths are syphilis and hæmatocœle, the early craggy involvement of the epididymis and the nodules in the vas, prostate, &c., of tubercle render confusion with this unlikely. From hæmatocœle diagnosis is often difficult, about half the scrotal swellings supposed to be tumours turn out to be hæmatocœles, fortunately for the patients. It is the more slowly growing varieties of tumour that are likely to be confused with hæmatocœle, but the history of injury and the rapid appearance of a tumour which later tends rather to shrink than to grow is in favour of a hæmatocœle. Involvement of the vas and lumbar glands is good evidence of tumour, but points to a hopeless prognosis ; it is necessary to make the diagnosis before this becomes dangerously easy. From syphilitic orchitis the diagnosis, when the tumour is small, is hardly possible, only where the tumour is large beyond the probabilities of inflammation or where invasion of the cord or metastases is present can one be certain, and this is too late. The practical con- clusion is that when a regular swelling of the whole testis appears without any history of injury, always to suspect its being a new growth and not to wait more than fourteen days before exploring and, while waiting, giving heavy doses of iodides which will cause rapid diminution where the swelling is gummatous. If on exploration the tumour is a hæmatocœle or gumma, no harm is done since evacuation of the clot or slough is good treatment. Early exploration of doubtful swellings of the testis is the only safe method of diagnosis ; on the other hand exploration should always be done before a " tumour " is removed since many of these turn out to be hæmatocœles. The minute structure of a new growth is of little importance, but its malignancy concerns the surgeon; the rapidity of growth and the appearance when cut are the best criteria, being fibrous and tough if innocent, soft and cellular if malignant ; but as most cases are malignant it is usually wiser when in doubt to regard the tumour as malignant and treat accordingly.

OPERATIONS FOR TESTICULAR TUMOURS. In the case of simple dermoids the cyst may be dissected out, leaving the testis. Where the condition is slow growing or of fibro-cystic or endotheliomatous nature, encapsuled and of several years duration, removal of the testis (castration) will suffice. The exploratory incision over the testis is prolonged up into the groin over the inguinal canal and the testis with its coverings of spermatic fascia pulled out ; the spermatic cord is transfixed, tied, and divided well above at the internal ring. The end of the spermatic artery is found and tied again separately, as it is likely to bleed if only tied with the whole cord. The testis is then removed and the wound closed.

In all other forms of tumour, whether cancerous or sarcomatous, a much more extensive operation is indicated, if the patient is fit to stand it, for involvement of the lumbar glands takes place so early that unless

these be removed recurrence in them is almost certain, though cases of cure are occasionally reported after simple castration.

Operation. The exploratory incision in the scrotum is firmly sutured and a long incision made passing up and back from the external ring to the costal margin. This incision opens the inguinal canal, splitting the external oblique nearly to the ribs. The internal oblique and transversalis are cut across their fibres in the line of the incision and the peritoneum and transversalis fascia stripped from the back of the abdomen, which is freely exposed. The cord is traced up to the point where the vas leaves it, at which point the latter is divided and the surrounding iliac glands removed. The spermatic vessels and lymphatics, with the fat surrounding them, are freed from the posterior abdominal wall up to their junction with the aorta and vena cava, the glands of the lumbar chain in this region are dissected away and the spermatic vessels tied and divided. In this way the area of lymphatic drainage is dissected away with some completeness, though it is not possible to make sure that all the glands prone to infection are removed as the lymphatic spread is wide, especially on the left side, where the presence of the aorta renders dissection difficult. The lower end of the incision is then extended round the half scrotum and the enlarged testis with all its coverings can thus be removed in one piece with the vessels and lymphatics. The large abdominal wound is then closed in layers. After operation prophylactic treatment with X-rays to the lumbar region is advisable, since even after an operation of this magnitude recurrences are only too frequent.

Fungus Testis. This condition, sometimes known as " hernia testis," consists of a granulating mass projecting from the interior of the testis through the tunica albuginea, spermatic fascia, and skin, formed of granulations, testicular tissue or growth ; this results from suppurating wounds, suppurative orchitis, whether tuberculous or pyogenic, from breaking down gummata and infiltrating new growths, especially cancer.

Treatment. In the suppurative forms curetting away granulations, painting with pure carbolic, and aseptic dressing may result in cure, for tubercle excision, for syphilis mercury and iodides, possibly excision, will be required, while in the case of cancer free excision is indicated.

Alterations in the Nutrition of the Testis. (a) Atrophy results from :

(1) Old age.

(2) As the result of inflammation of the testis or epididymis, *e.g.* from mumps, gonorrhœa, syphilis, &c.

(3) As the result of pressure and malnutrition as when following hydrocœle, hæmatocœle, varicocœle, or the compression of the cord from tight closure of the canal in a radical operation for hernia.

(4) The failure in development or aplasia of an undescended testis should be distinguished from atrophy.

(b) Hypertrophy may occur in early life as the result of loss of the other organ from accident or disease.

Neuralgia of the Testis. Pain in the testis without physical signs is usually found in neurotic patients, sometimes associated with varicocœle or masturbation. This must be distinguished from referred pain due to disease of the kidney, bladder, prostate, rectum, &c. The pain is paroxysmal and intractable.

Treatment should be on general lines ; tonics, such as iron, arsenic, strychnine, valerian, being tried and outdoor exercise in moderation.

AFFECTIONS OF THE VESICULÆ SEMINALES

Inflammations are due to infection with the gonococcus and tubercle bacillus. *Gonorrhœal infection* may be acute or chronic ; both forms are sequelæ of posterior urethritis.

Acute vesiculitis consists of a mucopurulent catarrh of the organ, sometimes leading to abscess formation.

Signs. Perineal pain increased by defæcation, and frequency of micturition ; on rectal examination the tender swollen vesiculæ can be felt, if suppurating they are œdematous and boggy ; a posterior urethritis is present.

Treatment. The affection usually clears up under the treatment for posterior urethritis, but if suppuration result the abscess should be opened from the perineum guided by a finger in the rectum (as in the case of prostatic abscess) rather than risk its opening into the rectum.

Chronic vesiculitis often accompanies posterior urethritis and accounts for the difficulty of cure in some instances of the latter disease.

The symptoms are those of prostatitis, the enlarged vesiculæ being felt per rectum.

Treatment. This is as for chronic prostatitis, especial stress being laid on massaging out the contents of the vesiculæ.

Tuberculosis of the Seminal Vesicles. This is secondary to tubercle of the testis or prostate, and detected on rectal examination by feeling hard nodules and enlargement of the vesiculæ, which later break down to form cold abscesses. These abscesses should be opened and scraped from the perineum to avoid their bursting into the rectum, which will cause the formation of intractable fistulæ.

AFFECTIONS OF THE SCROTUM

Injuries have already been discussed.

Of inflammations eczema occurs in the superficial layers and cellulitis more deeply. Eczema of the scrotum may be acute or chronic.

(1) *Acute eczema* usually results from irritation of dribbling urine, hence often found in neglected infants, but also in older persons from the dribbling associated with stricture or enlarged prostate, especially where the urine contains sugar, which has a very irritating effect on delicate skins, as shown by the " grocer's itch " arising from handling moist sugar. Attention to cleanliness, diminishing the sugar in the urine by diet, and

locally covering the scrotum with soothing lotion or ointment, of which the best is that of the glycerine of the subacetate of lead, will cure most cases.

(2) *Chronic dry eczema* with a harsh, rough, even warty skin may result from the irritation of pediculi, dirty clothes, but especially from certain trades in which irritating substances obtain free access to the skin, *e.g.* soot in the case of sweeps, or the products of decomposing hydrocarbons in those who work in tar and paraffin. The importance of this condition is from the frequency with which warts develop, which at any time may become cancerous. The condition is cured by alteration of work, cleanliness, soothing ointments, and careful removal of warts before there is any chance of malignancy developing.

ERYSIPELAS AND CELLULITIS OF THE SCROTUM. Mention has been made already of cellulitis of the scrotum following from infection from the urethra, usually due to leakage behind a stricture, sometimes from an infected urethra without stricture. Infection may also occur on the surface of the scrotum, in scratches, &c., with streptococci, followed by cellulitis. The onset is sudden, the scrotum swelling rapidly, becoming huge, œdematous, red, tense, and boggy ; the patient has high fever and feels very ill, but there is no difficulty with micturition or urethritis. The inflammation may proceed to abscess formation, or severe sloughing, or may subside.

Treatment. Free incision is made in the midline of the scrotum, abscesses are opened, and the urethra investigated for stricture, to exclude extravasation of urine. Hot moist dressings and, later, warm baths of mild antiseptics will assist in clearing up the infection, general tonic and stimulant treatment as regards diet is essential. Early and free incision will save much sloughing and toxic absorption, but the scrotum always heals well over the testes however much is lost.

Scrotal fistulæ of urethral and testicular origin have been discussed. *Œdema of the scrotum,* associated with general dropsy of renal or cardiac origin, is to be distinguished from the inflammatory swelling of cellulitis, as in some instances the latter will show little redness. The œdema elsewhere in legs and back, albumen in the urine or some cardiac lesion, and absence of fever will exclude cellulitis.

ELEPHANTIASIS OF THE SCROTUM. This is a fibrous and lymphatic hypertrophy of the soft parts of the scrotum due to blocking of the lymphatics with filaria embryos. The result is an enlargement of the scrotum, which in some instances can only be described as prodigious, the mass hanging below the knees, weighing a hundredweight or so, and requiring carriage on a wheelbarrow to permit of the patient's progression. The skin is tough, rough, warty, and may discharge lymph.

A milder degree of this affection may follow extensive destruction of the lymph channels in the groin from suppurative or syphilitic lymphadenitis. In some instances the tunica vaginalis is distended with chyle " chylous hydrocœle."

Treatment. The redundant scrotum is removed by dissection. The part is elevated for some hours, a tourniquet then placed round the base, and this is prevented from slipping down by skewers transfixing the scrotum. Flaps are dissected up and the penis and testes carefully dissected out of the mass, which is then removed, a somewhat arduous task.

CANCER OF THE SCROTUM. This usually follows as a final change in the rough, warty skin of chronic eczema ; in one instance we found this associated with cancer of the penis, and, from its position, there had apparently been infection by contact. The growths may be multiple and

FIG. 223. Epitheliomatous ulcer of the scrotum in a chimney-sweep.

have the characters of epithelial cancer elsewhere, viz. callous, slowly progressing ulcers with everted edges, hard infiltrated base, and dry floor, metastatic deposits form in the inguinal glands, but spread is relatively slow.

The testis may become involved by local spread, and from this there is spread to the lumbar glands. In some instances the deposits in the inguinal glands break down, rapidly forming ulcers which erode the vessels, causing fatal secondary hæmorrhage.

Treatment. The ulcer should be excised with a wide margin of healthy tissue, together with the inguinal glands, the whole in one piece. Where the testis is affected, this is also removed. All warts should be removed and the eczematous condition treated to prevent formation of fresh warts and cancer.

SECTION VIII

SURGERY OF THE THORAX AND BREAST

CHAPTER XXXVI

SURGERY OF THE BREAST

Anatomy and Examination : Congenital Defects : Affections of the Nipple ;
Eczema : Chancre : Paget's Eczema.
Acute Mastitis : Acute Mammary Abscess : Chronic Pyogenic Abscess : Tuber-
culosis : Syphilis : Involution, Fibro-cystic Degeneration, Chronic Interstitial
Mastitis : Cysts : New Growths : Fibro-adenoma : Quasi-malignant Tumours,
Cysto-adenoma, Duct Papilloma : Malignant Growths : Sarcoma : Cancer—
Types, Spread, Diagnosis, Prognosis, Treatment : The Male Breast : Operations
on the Breast.

Anatomy. The breast, which except during lactation is functionless,
consists in the quiescent period of scanty alveoli, lined with flat or cubical
epithelium, lying in a stroma of connective tissue, which contains much
fat. The alveoli are grouped into lobes to the number of about twenty,
each of which opens separately by its own duct on the surface of the central
pigmented projection or nipple, the skin of which is corrugated and sur-
rounded for an inch and a half by a pigmented areola. The breast lies on
the pectoralis major and anterior part of the serratus magnus, extending
from the second to the sixth rib in the vertical direction and from the edge
of the sternum to the mid-axillary line horizontally, being thus a good deal
larger than appears on the surface, as its borders are ill-defined, merging
into the surrounding fat. An axillary lappet of the gland extends up under
the pectoralis major, and may be the seat of cancer. This wide extent
of the organ is of importance when considering the question of its complete
removal for cancer. During lactation the breast becomes larger and far
more vascular, the alveoli increasing in size and numbers, while the cells
become of a more columnar shape and contain granules of fat and albu-
minoid material, from which the milk is formed. Owing to the increased
activity and vascularity of the gland, the growth of tumours is more rapid
during pregnancy and lactation. From the stroma of the gland, septa
of connective tissue pass to the skin and underlying muscles to maintain
the organ in its place, and the lymphatics of these septa form paths
along which cancer readily spreads to the skin and deeper structures,
producing in their course fibrosis and fixity of the breast.

The blood-supply is derived from the external mammary branches of
the axillary and the upper perforating branches of the internal mammary.

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The lymphatic drainage is very extensive. From the skin over the breast the lymph drains direct into the axillary glands. The glandular lymphatics follow the ducts to a considerable extent, forming a plexus under the skin of the areola (subareolar plexus), while in addition another plexus is formed in the pectoral fascia under the breast, as well as on the upper part of the
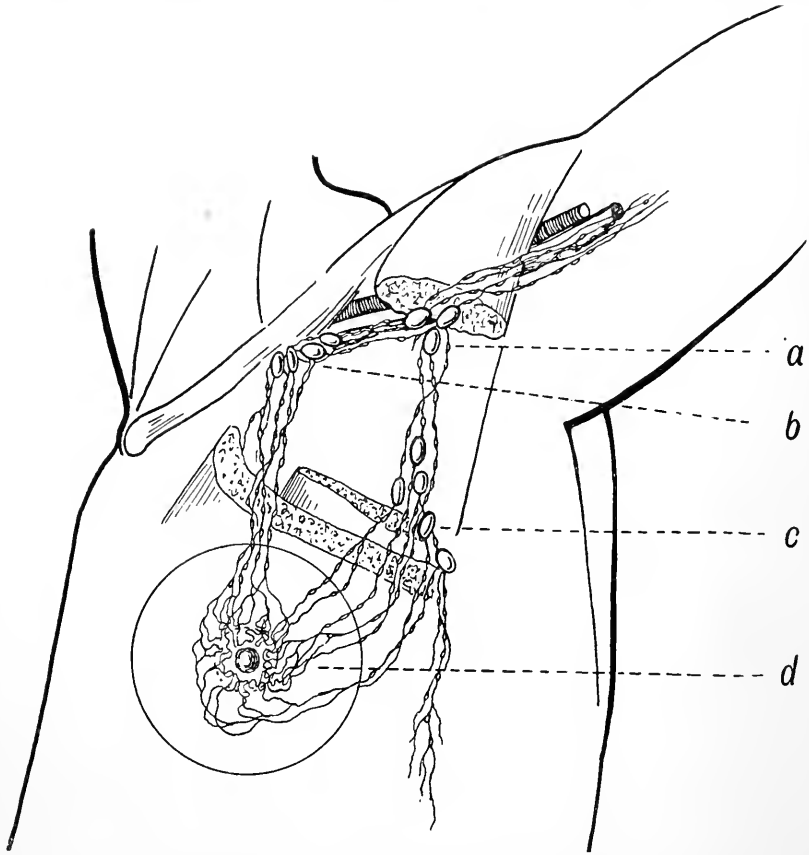
FIG. 224. Lymphatics of the breast. *a*, Central axillary glands. *b*, Subclavian glands. *c*, Pectoral glands. *d*, Areolar lymphatic plexus.

anterior layer of the sheath of the rectus abdominis (which is continuous with the pectoral fascia). From the subareolar plexus efferent vessels drain into the central axillary and pectoral groups of glands and one trunk passes into the subclavicular group, which lies on the axillary vein high in the axilla as it crosses the first rib. The lymphatics communicate freely with those of the opposite breast, and below with those of the abdominal wall and peritoneum, which explains the spread of cancer to the liver (Handley). There is also some drainage into the subscapular and supraclavicular glands, which is probably made use of when the direct route into the axillary and pectoral glands is blocked. In addition some lymphatics run with the perforating branches of the internal mammary vessels to the glands in the anterior mediastinum.

EXAMINATION OF THE BREAST

The condition of the breast should be noted as regards size and pendulousness, condition of the nipple, and any visible swelling. The differences between virginal, lactating, and involuting breasts should be recognized. The virginal breast is a smooth rounded swelling, the nipple slightly prominent and pink in blondes, but pigmented in brunettes ; the surface is smooth, the consistency firm and elastic, and it is mobile on the pectoral muscle. During pregnancy, and still more during lactation, the breast enlarges, the areola becomes much more pigmented and the superficial veins distended, so that at the height of lactation the congestion almost suggests an inflammation. After lactation the breast becomes flaccid, often pendulous. The atrophic breast at the menopause or earlier, becomes shrunken, knotty, usually pendulous, sometimes over-laden with fat, or small and shrunken on to the ribs ; the substance feels stringy and the small nodes due to retention-cyst may be felt.

When diseased the breast on the affected side may appear higher than the normal organ from the contraction of fibrous tissue, whether of inflammatory or neoplastic origin. The nipple may be retracted congenitally, from inflammation, or from growth and fibrosis. Rawness and cracks of the nipple should be noted as well as any discharge of blood or serum (suggesting papilloma or cancer of the ducts) and ulcers, sinuses, or fungation of the breast proper.

Palpation with the flat of the hand and with the fingers may reveal a tumour, which must be investigated as to its adherence to the skin and deeper structures. To ensure fixity of the pectorals the patient presses the hands together, or the muscle may be moved with an adherent growth. The outline and mobility of the mass in the breast is tested and examination made for fluctuation. The other breast, the axillary and supraclavicular glands and liver are searched for secondary deposits. Finally it must be fully recognized that an exploratory operation is frequently essential to ascertain the innocency or malignancy of any tumour of the breast.

CONGENITAL DEFECTS. Absence of one or both breasts is occasionally met with, most usually in males, being then of no consequence.

Supernumerary nipples are not infrequent, occurring on the abdominal wall or in more distant situations such as the buttock. If inconvenient for cosmetic or other reasons such nipples are removed by excision.

AFFECTIONS OF THE NIPPLE AND AREOLA. Retraction of the nipple may be due to congenital origin or the result of fibrosis, both from inflammation and new growths. In the former instance it may interfere with suckling, in the acquired forms it is merely a physical sign.

Where retraction of the nipple interferes with suckling, attempts may be made to elongate it with the help of the breast-pump, but if this prove painful, or should cracks develop, the breast should be left alone, and if the other be insufficient for the needs of the infant, the diet of the latter is supplemented with the bottle.

CRACKS AND FISSURES OF THE NIPPLE. These are in reality small ulcers due to inefficient hygiene during lactation or prolonged suckling, and are important as affording a ready ingress to infection, which in turn leads to mastitis or mammary abscess.

Prevention. The nipples should be kept carefully cleaned during the latter months of pregnancy and methylated spirit applied, after washing, to toughen the skin. During lactation the nipples are carefully dried and cleaned after each act of nursing, and dusted with boric powder to prevent the skin becoming sodden, which leads to chafing and chapping of the delicate skin. When cracks arise the infant should be kept on the other breast till healing takes place ; the breast on the affected side is emptied with the pump, cleaned with dilute carbolic lotion, and dusted with boric powder : where healing is delayed the small ulcer is touched with solid silver nitrate.

ECZEMA OF THE NIPPLE. This is often associated with the above-mentioned cracks during lactation. The condition is treated on similar lines, the infant being debarred from using the affected breast, the nipple cleaned and covered with gauze wrung out of lotio glycerini plumbi subacetatis or the ointment of the same material. The condition must be carefully distinguished from the far more serious eczema of Paget.

CHANCRE OF THE NIPPLE. This is a not uncommon result of a normal wet-nurse suckling an infant suffering from congenital syphilis.

The local condition varies from a chronic, non-healing fissure to a flat, raw, superficial ulcer, with some surrounding induration associated with enlarged indolent glands in the axilla.

Diagnosis. The latter type is not unlike Paget's eczema but advances more rapidly up to a point, the surface is less raw and weeping and the colour of a more dull red, while the enlargement of axillary glands is much earlier, occurring in a few weeks, in which time, where the condition is a chancre there will be a large ulcer and much glandular enlargement, while many months or years are needed to produce so large a lesion where the condition is that described by Paget. Finally, the serum reaction, the presence of spirochætes in scrapings, and timely appearance of secondaries will decide the question. Both nipple and areola may be involved and the affection may be bilateral.

Treatment is as for generalized syphilis.

NEW GROWTHS OF THE NIPPLE. Sebaceous cysts, papillomas, and occasionally epithelioma are found, but none of these are common.

PAGET'S ECZEMA. Though by no means common, this is the most characteristic and important form of new growth of the nipple, interesting alike from its association with the name of a great clinician and from the danger of confusing it with less virulent disease. The affection has been called eczema on account of the raw weeping surface presented, but its chronicity, the invasion of deeper structures, and the microscopical appearance sharply distinguish it from the less noxious condition. This affection consists of a superficial squamous-celled cancer, in which the tendency to

local infiltration is but small and slow, but the absence of basement membrane below the epithelium and the manner in which the latter merges into the deeper structures reveals the nature of the disease. The downgrowths of epithelium being slight, the hard infiltration around, so characteristic of most squamous-celled cancers (epitheliomas), is wanting, but secondary deposits will readily be noted in the axillary glands (Fig. 226). The primary

FIG. 225. Paget's eczema of the nipple, showing destruction of the latter, and a raw surface around.

growth may invade the lactiferous ducts of the nipple and may be associated with the condition commonly known as duct-cancer : sometimes discharge from the nipple, possibly due to duct-cancer, precedes the " eczema."

Clinically the disease commences about the menopause (very different from true eczema, which is usually found in lactating breasts) ; the skin of the nipple and areola becomes red, rough, scaly, and later weeping and raw and quite unaffected by soothing lotions and ointments, under which real eczema heals. Later the axillary glands are enlarged and hard, while solid masses may be felt in the breast presenting all the physical signs of cancer. The condition bears an interesting similarity to certain forms of atrophic glossitis and some of the initial stages in cancer of the glans penis.

Diagnosis. This is made on the chronicity, the age of the patient, by exclusion of syphilis (chancre), and by its not yielding to soothing applications.

Treatment. Doubtful eczematous patches not readily healing under suitable treatment in women of middle age and over should be excised, and where the microscopical section shows that the condition is not simple
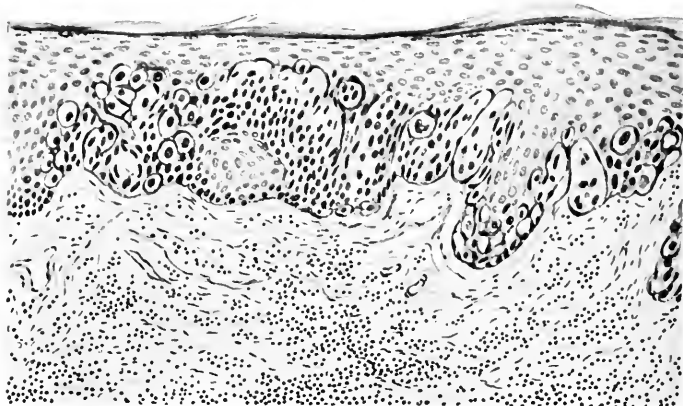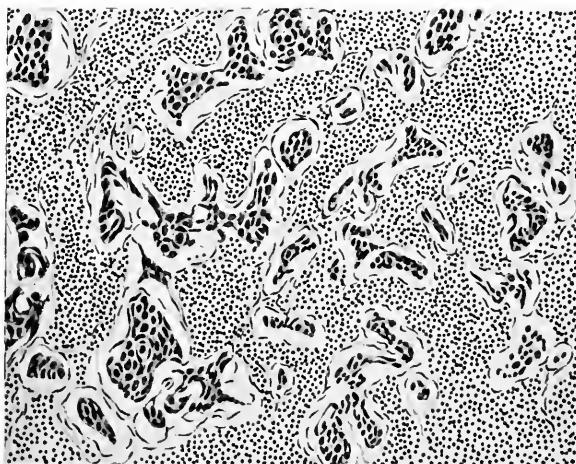
Fig. 226. Paget's eczema of the nipple (magnified). A, The deeper epithelium is atypical and is not well separated from the underlying dermis. B, Axillary gland (magnified). Containing deposits of atypical epithelial cells, secondary to Paget's eczema.

eczema, or where enlarged hard glands are present, the breast and pectorals should be removed and the axilla cleared of glands as for other cancers of the breast.

AFFECTIONS OF THE MAMMA PROPER

HYPERTROPHY OR HYPERPLASIA. The latter term is better, since there is no increase of function but rather the opposite. The increase is often bilateral and affects the gland substance to some extent, but the interstitial substance and fat more so. No treatment is of avail except excision, which is adopted when the mass becomes too unwieldy.

INFECTIONS AND INFLAMMATION (mastitis). *Acute Inflammation.* This occurs at three periods of life, viz. at birth, puberty, and during lactation, and is due in the first place to infection, though in each type there is an underlying physiological activity and hyperæmia which would appear to play some part in the affection.

(*a*) *Mastitis of Infants.* There is swelling and induration of the breast, and some secretion of a milky appearance. The condition if left alone subsides ; should, however, the busy nurse rub and pinch the congested and slightly inflamed breast, some organisms will possibly be rubbed into the delicate skin of the nipple, and infection spread along the lymphatics to the gland, causing more severe inflammation, which may terminate in the formation of an abscess.

Treatment. The slighter cases will resolve if left alone after a few days ; where more severe, fomentations will relieve the pain, and where suppuration results the abscess is opened and drained.

(*b*) *Mastitis of Puberty.* This may occur in either sex and is far from uncommon in boys ; indeed in some races an attack of mastitis is considered the normal proof of the onset of puberty. The inflammation is usually of a mild nature, readily subsiding, and suppuration is rare.

(*c*) *Puerperal or Lactation Mastitis* (acute lobar mastitis). This is much the most common form of acute mastitis ; others, such as metastatic involvement in mumps, other exanthemata, or pyæmia, are unusual. Mastitis of the active breast usually occurs either in the first few weeks after delivery, owing to the formation of small lacerations of the unused and unaccustomed nipple, which afford entrance for infective organisms to the breast, or it arises in the later months of nursing, when the health is perhaps depressed from prolonged lactation ; during pregnancy mastitis is uncommon. The organisms responsible are staphylococci and streptococci. The inflammation may subside rapidly on suitable treatment or proceed to suppuration (mammary abscess).

The following forms or stages may be recognized :

(*a*) *Acute Diffuse Mastitis.* The breast becomes engorged, firm, knotty, and tender on palpation, the veins over it being over-distended, and fever is present. Some consider this to be a physiological congestion (milk-congestion, milk-fever), but it is more probably an early or mild form of acute mastitis.

Treatment consists in forbidding the affected breast to the infant, cleaning the nipple with weak carbolic lotion, depleting the breast of milk with the breast-pump or with Klapp's suction-glasses, and supporting the organ with a sling. In some instances the breast will recover and can be used again, but more often will have to fall into disuse for the present lactation.

(*b*) *Acute Lobar Mastitis.* Where the inflammation is more acute and further advanced it will generally be found to pick out one or more lobes, so that there are found indurated, tender portions of the breast of sector shape, corresponding with the lobes involved. This condition may also subside on the treatment described, but more often there will follow :

(c) *Acute Mammary Abscess* (acute suppurative lobar mastitis). This is indicated by throbbing pain, deep-seated fluctuation in the indurated lobes, and later redness and œdema of the skin, with irregular fever and possibly rigors.

Treatment. As soon as fluctuation indicates that suppuration has definitely occurred the abscess should be opened and the child weaned. Often these cases are left untreated far too long, till redness and œdema of the skin make diagnosis easy, by which time the abscess will have tracked and pocketed in various directions, rendering drainage difficult and ultimate cure prolonged, besides destroying far more breast-substance than is needful if more rational measures be adopted. Where there has been a tender induration for some days with irregular fever, even if fluctuation be doubtful, the wiser course is to make a radial incision (to avoid cutting the lactiferous ducts) into the middle of the mass : pus will almost certainly be found and convalescence be rapid. Where abscesses have been allowed to track about the breast for some time care should be taken to open all the pockets and arrange drainage, with a wide tube, at the lowest part of the abscess ; the tube should not remain in longer than four to seven days or a fistulous track will result. Where several lobes are involved each abscess is opened by a radial incision. Klapp's method of suction can be serviceably applied to the sinuses resulting on opening these abscesses, and should cause rapid healing. The sinuses which so often remain after opening mammary abscesses are partly the result of waiting too long before using the knife, and partly from leaving in the drainage-tube too long, *e.g.* several weeks. Such sinuses, when persistent, should be laid freely open in a radial manner, scraped and lightly packed with gauze, which is entirely removed after a few days.

Other less common forms of suppurative mastitis are :

(d) *Subareolar or pre-mammary abscesses*, which are small subcutaneous abscesses under the areola, easily recognized and soon cured by free incision and drainage.

(e) A still less common form is the *submammary or retro-mammary abscess*, which may result from the extension backwards of a suppurative lobar mastitis. More often such an abscess is not connected with the puerperium but follows necrosis of the ribs or a pointing empyema, &c., and may be subacute or chronic. In such cases the breast forms a conical swelling floated up on a bed of pus, being itself unaffected. The abscesses are opened at the lower outer part and may heal on drainage, but it may be necessary to reflect the breast with the superficial tissues to obtain free access to an empyema, necrosed ribs, &c.

CHRONIC INFECTIONS AND INFLAMMATIONS

None of these conditions are common.

(a) CHRONIC PYOGENIC ABSCESS. The origin is often uncertain : sometimes such abscesses follow on acute lobar mastitis in which acute suppuration does not take place ; the inflammatory mass does not resolve properly,

and later a definite tumour is found which fluctuates ; sometimes infection of injured gland-substance in the inactive breast, as from blows or corset-pressure, may be the cause ; or infection and suppuration may arise in a cyst of any sort.

Diagnosis. This condition is important because it closely resembles cancer of the breast, since there is a lump in the breast with ill-defined edge and fixed in the breast substance ; adherence to the skin and deep structures are only noted where the abscess is large, but the nipple may be retracted, and, unlike early cancer, there is pain and tenderness referred to the lump. Careful palpation will reveal fluctuation in the centre of the mass, or at any rate the centre feels less dense than the periphery, while in cancer the centre is the hardest part. Where there is any doubt the mass should be cut into freely before complete removal of breast, pectorals, &c., is performed.

Treatment. Where possible the abscess should be excised entire with its wall, the wound in the breast being brought together with deep sutures so that first intention is secured, for if simple drainage be employed a sinus is likely to persist, owing to the dense fibrosis around.

(*b*) TUBERCULOSIS OF THE BREAST. This is quite uncommon, usually arising late in a case of phthisis. Nodules form in the breast, which break down into cold abscesses and finally burst through the skin, forming multiple sinuses. Thus in its origin, the condition resembles fibro-cystic disease, and later, one of acute abscess which has been allowed to pocket and burrow.

Treatment. Where the patient's health is otherwise fairly good the breast should be removed completely and any tuberculous axillary glands as well. In most instances the sinuses will be curetted and filled with bismuth paste, as the general condition usually precludes any radical measures.

Actinomycosis of the breast presents similar signs, and the diagnosis is made by finding the ray-fungus in the discharge.

SYPHILIS OF THE BREAST. Chancre of the nipple and its importance in diagnosis have been discussed. Mucous patches and condylomata occur about the nipple and the folds of pendulous breasts during the secondary stage of the disease.

Gummata are very uncommon, but occur as nodes in the breast which may at first be taken for cancerous tumours but soon break down on the surface, when the resulting gummatous ulcer is unmistakable.

AFFECTIONS ASSOCIATED WITH INVOLUTION OF THE BREAST ; FIBRO-CYSTIC DEGENERATION. Towards the menopause, and in some instances long before this, changes take place in the breast, which begins to lose its function as a milk-producing gland. The glandular acini become atrophic and there is a formation of excessive fibrous tissue around the alveoli and ducts. This condition is sometimes described as " interstitial or lobular mastitis," but the evidences of inflammation are but slight, unless we consider the fibrosis to be of this nature. It seems more reasonable to regard the changes as part of a degenerative process, since they are found to some

degree in all breasts which have lost their potential function. Not infrequently cysts arise in these fibrous breasts, apparently being retention-cysts resulting from the snaring of the alveoli and ducts by the fibrous tissue. The method of cyst-production is, however, uncertain, and we can only say that excess of fibrous tissue and cysts frequently occur together in breasts which are degenerating; it should be noted that the breast fairly often undergoes involution considerably before the menopause.

The fluid in the cysts may be thin and clear, straw-coloured or dark, while sometimes it is of a colloid consistency. For the above reasons the name *fibro-cystic degeneration* seems better than chronic mastitis.

Signs. The patient may complain of pain, sometimes of a tumour. On examination the breast is usually atrophic, the skin loose and puckered; the nipple is often retracted, and a visible lump may be present.

On palpation the organ feels tough and stringy, while small nodules (little cysts) are often felt scattered through its substance. The affection is usually bilateral, though generally more marked on one side than the other.

Where a lump is present this is usually fairly well defined, somewhat mobile in the breast-substance, and not hard; while should it consist of one or more large cysts, fluctuation will be detected, but if it consist of a collection of small cysts the mass will simply feel elastic.

The affection is essentially chronic, the cysts remaining stationary for a long while: new cysts may form or the fibrous tissue become increased without any formation of cysts.

Cancer certainly develops in breasts when in this condition, but whether more often than in normal breasts is difficult to ascertain, since involution changes are so common.

Treatment. In the more purely fibrous forms with pain, occurring about the menopause, the breast should be bandaged up, counter-irritants such as Scott's dressing applied, and appropriate tonics such as valerian administered internally, which may relieve the condition till the ultrasensitive stage has passed off. Where a definite lump is present exploration is often indicated to exclude malignant disease, and having excluded the latter, it is often well to remove a useless organ which may become cancerous. Even where the diagnosis is certain and there is no pain it is perhaps wiser to remove the breast, since the operation is but slight and we cannot be quite certain that involution does not predispose to cancer. Taking this view places one in the position of removing unnecessarily a number of involuting breasts; still this is better than to allow cancer of the organ to obtain a start, since with all improvements of technique the recurrence of cancer of the breast after operation is considerable and the removal of a potential focus in the shape of a useless organ seems sound policy; moreover, as one writer has aptly put it, a woman with a lump in her breast is not a happy woman, even though assured of its complete innocency.

CYSTS OF THE BREAST. These may be divided into involution cysts, retention cysts, cysts of new growth, hydatids, and serous cysts.

Involution cysts have been sufficiently described in the last section under Fibrocystic Degeneration or Chronic Mastitis.

Cysts related to neoplasms will be discussed later.

Hydatids are rare in this country and present the characters of hydatids elsewhere, viz. painless, cystic swellings liable to suppurate after some while and often undiagnosed till explored.

Serous cysts may result from the dilatation of lymph-spaces ; probably most cysts described under this name are simply involution cysts in which the contents are particularly clear and limpid.

There remain to be considered retention cysts, or " galactocœles."

Galactocœles occur in the lactating breast from blockage of one of the main ducts in the region of the nipple, presumably from some inflammatory process. The result is a localized dilatation of the duct, which assumes the form of a cyst, containing milk more or less altered into cheese, in accordance with the duration of the cyst.

Signs. The appearance of a cystic swelling near the nipple, under the areola, during lactation, which grows fairly rapidly as long as lactation lasts and then ceases, the cyst shrinking considerably, points to the nature of the condition. After almost disappearing with cessation of lactation, these cysts may reappear at the next pregnancy and lactation.

Treatment. If not interfering with suckling the cyst should be left till that period is over, and if still persisting should then be dissected out.

NEURALGIA AND NEUROSIS OF THE BREAST. Pain in the breast occurs in young women apart from any physical signs, is associated with uterine trouble such as dysmenorrhœa, and is worse at the menstrual periods. This should be treated by attention to the general health, tonics, and impressing the patient that nothing serious is the matter ; associated uterine disorders should be treated.

NEW GROWTHS OF THE BREAST

Clinically, tumours of the breast may be divided into innocent, malignant, and quasi-malignant.

The only innocent form which is at all common is the fibroma or fibro-adenoma ; lipomas and chondromas are described, but are so rare as to be simply pathological curiosities. The malignant forms include cancers and, far less commonly, sarcomas of various kinds ; in the quasi-malignant group we include duct-papillomas, cystic adenomas and papilliferous cysts, since these tumours seldom possess more than local malignancy, though often appearing at first sight highly malignant, and if removed early show little, if any, power of dissemination.

FIBRO-ADENOMA ; PERIDUCTAL FIBROMA. These are sometimes described as adenomas or fibromas, and in most cases deserve the latter title, since they consist chiefly of fibrous tissue arranged in whorls, surrounding a few scattered ducts which are lined with cubical epithelium (hence the term periductal fibroma) ; these tumours possess a well-defined capsule.

Signs. The growth commences in adolescent or early adult life, usually before thirty, as a circumscribed, firm lump, extremely mobile in the substance of the breast as well as on the superficial and deep structures (unless anchored by some inflammation or fibrosis of independent origin). Pain or tenderness is unusual except sometimes during the menstrual periods.

Diagnosis. The mobility, well-defined edge and firmness of their texture, without fluctuation or hardness, readily distinguishes from involution
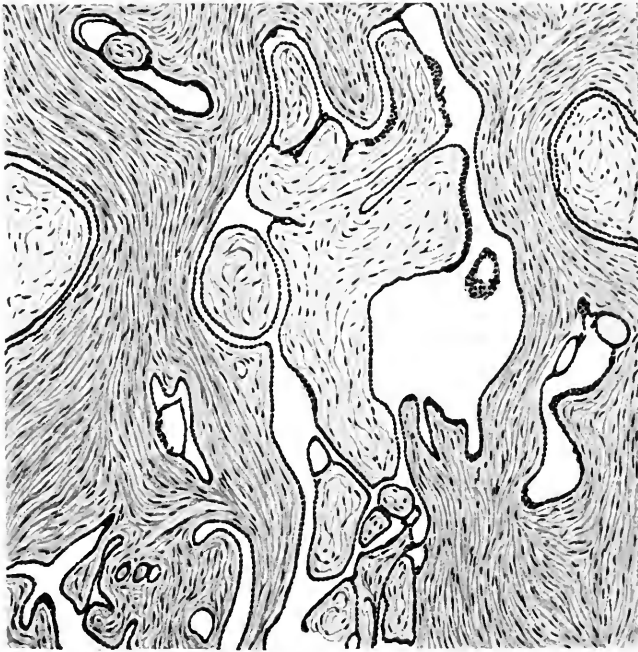
Fig. 227. Periductal fibro-adenoma of the breast (magnified).

changes (chronic mastitis) and cancer ; when associated with the former condition, however, the signs closely resemble those of cancer.

It is uncertain how far these tumours can undergo malignant changes ; closely allied in structure are the periductal sarcomas and periductal myxomas, consisting of spindle or myxomatous cells arranged round ducts which grow rapidly and which are perhaps developments from the innocent fibroma and belong to the quasi-malignant or malignant group, showing rapid growth and cyst formation.

Treatment. These tumours should always be removed, since they grow indefinitely and malignancy may supervene at any time ; moreover, early removal is a slight and simple operation. They are removed either through an incision radiating from the nipple over the most prominent part or by turning the breast up (*see* Operations on the Breast, p. 690) ; in either case enucleation is tolerably easy.

QUASI-MALIGNANT GROWTHS. (*a*) *Cysto-adenoma* is also described as sarcoma, cystic sarcoma, intracanalicular adenoma, proliferous cysto-adenoma,

terms which describe various types and phases of growth. The tumours contain more epithelial (gland or duct)-material than the periductal fibroma : the ducts proliferate, forming cysts, into which may project warty or papilliferous masses covered with epithelium. These tumours are found in the second half of sexual life and grow rapidly, but are encapsuled, seldom, if ever, form metastases, and are cured by complete removal of the breast. As regards clinical signs and course they are closely related to the periductal sarcomas mentioned above.

Signs. These growths are found during the later part of sexual life as well-defined masses closely resembling in their early stages the fibro-adenoma of young persons but growing far more rapidly, so that in a few months they may assume huge proportions. Fluctuation in parts is often noted, owing to the presence of cysts, and the mobility is soon limited owing to sheer size. The skin over the mass becomes thin, bluish, and gives way, allowing a fungating mass to escape, which soon becomes infected, sloughy, and foul. Even at this stage there is little tendency to escape from the capsule, and secondary deposits in the axilla or elsewhere, if occurring, are very rare ; true malignancy is seldom present in spite of the fearsome appearance of the fungating mass.

Fig. 228. Cysto-adenoma of the breast in section, showing intracystic polypoid growths. Microscopically the growth was a fibro-adenoma undergoing sarcomatous and myxomatous changes.

Diagnosis. In the early stages the age, rapid growth, and fluctuation in parts will distinguish from fibroadenoma. In the later stages, when large and fungating, they are distinguished from encephaloid cancer or true sarcoma by the fact that although the skin has given way, it is simply stretched by growth and not infiltrated as in the latter conditions, while enlargement of the axillary glands will not be found.

Treatment. In the early stages the tumour might be enucleated locally as in the case of fibro-adenoma, but it is safer to remove the whole breast down to the pectorals, since the function of the breast is problematical and if not removed recurrence is likely.

In the later stages, when large and fungating, the entire breast should certainly be removed, and if the pectorals be excised and the axilla cleared as well the surgeon will be taking a wise precaution.

(b) *Duct Papilloma.* This is a form of papilliferous cysto-adenoma occurring during late middle life in one of the larger ducts close to the nipple, and may persist without much change for long periods, but later is apt to develop cancerous changes. The condition consists of papillæ growing into the duct with formation of cysts and fibrous tissue around.

Signs. A discharge of blood from the nipple is the first sign, sometimes alternating with serous discharge : a small tumour, which may fluctuate, will usually be felt in the vicinity of the nipple.

When malignant changes supervene the tumour grows rapidly, becomes hard and fixed, and the axillary glands are affected, the signs being those of ordinary cancer.

Treatment. Here also local removal is possible, but it is far more satisfactory to remove the whole breast, to obviate all chance of cancer forming later.

MALIGNANT GROWTH OF THE BREAST

Cancers and sarcomas both occur, the latter being very uncommon, amounting to about 2 per cent. of all cases, while cancers are the commonest of all breast tumours, of which they form about three-quarters.

SARCOMA. These are most usually found in middle life but are recorded at all ages. They develop in the stroma of the gland, portions of the alveoli being included in the growth. The sarcoma may be of round or spindle cells and possesses a capsule of sorts, but this is very adherent to its surroundings, and infiltration occurs, with spread to the axillary glands, lungs, and liver. The malignancy varies greatly ; cystic degeneration is common.

The course varies with the type of growth : those of spindle-celled formation grow more slowly and resemble fibro-adenomas to some degree but advance more rapidly than the latter, and if left soon show signs of invading their surroundings, and if removed locally will recur. The round-celled variety grow still more rapidly and undergo degeneration with formation of cysts, and soon form large tumours which ulcerate through the skin and form fungating masses, thus closely resembling cysto-adenomas, but fairly soon disseminating to the glands, lung, liver, &c.

Diagnosis. It will be noted that these tumours show considerable resemblance to fibro-adenoma and cysto-adenoma. From the former the more rapid growth, early fixity, cystic degenerations, and involvement of axillary glands will separate. From cysto-adenoma the diagnosis is often difficult, short of exploratory incision and microscopical examination ; the more adherent capsule and tendency to local invasion will point to sarcoma, the presence of papilliferous growths in the cysts, instead of broken-down blood-clot, will suggest cysto-adenoma, but owing to the uncertainty of diagnosis it is always advisable to perform a very wide excision in doubtful cases with the above clinical aspect.

Treatment. Where not too far advanced the breast and pectorals should be removed and the axillary glands cleared out as for cancer, but in the more rapidly growing forms the outlook is poor even when this is done.

Where there is doubt as to the nature of the growth it will be sound policy to perform the wide excision mentioned, since this is not very mutila-

Fig. 229. Advanced cancer of the breast; large nodular and cystic tumour involving a wide area of skin over the growth.

ting, and to remove incompletely an area affected with sarcoma and then a few days later to perform the more radical operation is likely to lead to disaster. Moreover, even microscopical examination is often of little help as regards prognosis in these tumours, and a better judgment can often be formed on the history, with regard to rate of growth, and the local examination than by the, reputedly, more scientific method.

CANCER OF THE BREAST. This is a tolerably common affection in women, in whom it occurs about a hundred times as often as in the male sex; indeed, next after the uterus, the female breast is the organ most frequently

affected with cancer. In both instances the sudden and extreme changes, in structure and function, and the enormous amount of work performed must increase the wear and tear of the organ, and may be of importance in the aetiology.

Structure. In the great majority of cases cancer of the breast is of the spheroidal-celled variety, taking origin in the cells of the acini or possibly of the smaller ducts. Far more rare is the columnar-celled type which arises in the larger ducts (duct-cancer). Mention has been made already of the squamous-celled variety, originating in the nipple and areola (Paget's eczema).

According to the manner of growth of the epithelium and the spread, as well as of the secondary degenerations, several types are to be distinguished structurally and clinically.

Ætiology. Little or nothing is known about the cause of cancer. Minor injuries, such as the pressure of corsets, blows, the irritation of suckling, have been held responsible, but on very scanty evidence, since most women wear corsets and have suckled. Heredity is also cited to account for cancer and good family histories are fairly often obtained, but in so common a disease this may well be a coincidence.

Types of Growth. Several forms may be distinguished, but it should be understood that these are only outstanding types, used for convenience in description; in practice one finds intermediate stages between all the groups, forming a complete series, from the most slowly growing atrophic variety, to the most acute and rapidly spreading form of encephaloid or inflammatory cancer. The types are distinguished mainly by the relation of the growth of the epithelium to that of the fibrous stroma, the manner of invasion, and the sort of degeneration which later occurs.

The following types may conveniently be distinguished : scirrhus ; atrophic ; acute, medullary, or encephaloid ; adeno-cancer (Halstead) ; cancer en cuirasse ; duct-cancer.

(1) *Scirrhus cancer* may be regarded as the mean type, of which most of the other varieties are variations or exaggerations, in respect of slowness or rapidity, of growth and spread. Microscopically the growth consists of atypical, spheroidal, epithelial cells which invade the fibrous stroma singly or in columns of varying size. The stroma is much thickened owing to the laying down of additional fibrous tissue, caused by the irritation of the invading epithelium, and this excessive amount of fibrous tissue accounts for the hardness of the mass when palpated.

Clinically the breast presents a hard lump in its substance, which from the spread of the cancer, along the fibrous trabeculæ and ligaments of the breast soon becomes firmly fixed in the breast-tissue and gradually adherent to the skin and underlying structures. The rate of increase is fairly rapid, so that in a few months the lump may be the size of a walnut to that of a small orange.

(2) *Atrophic cancer* usually occurs in old persons : the epithelial elements are few and scattered through masses of fibrous tissue, which, shrinking as

it forms, causes the organ to be much contracted ; the fibrous tissue in these cases is able to destroy and circumscribe the invading epithelium to a large extent, so that the spread is slow.   For the last reason the tumour-mass is relatively small and very chronic in character, often being present for years without any spread to internal organs.   The tumour is fixed to the skin and deeper structures, spreading laterally rather than into the depths ; the nipple is very often retracted.   Such cases may last ten years or more without any secondary deposits arising large enough to produce symptoms, and very occasionally complete healing may result.

(3) *Encephaloid or Medullary Cancer ; Acute Cancer.*   This is usually found in young subjects under thirty-five, and is characterized structurally
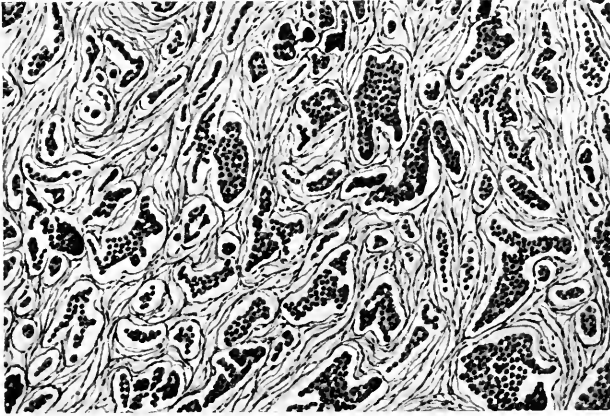
FIG. 230.   Carcinoma of the breast (magnified).   In the upper left part of the section the tendency is to the scirrhus or fibrous type ; lower and to the right the growth is more cellular.

by the great amount of epithelial proliferation compared with the fibrous stroma, the cells being in large masses and columns and often of extremely atypical form, large and multinuclear cells being fairly common.   Clinically these cancers are noted for the rapid growth and extremely fatal nature, recurring even after early, and most thorough operations.   During lactation occur the most malignant forms of all, from the increased activity of the breast at this period ; such cases are sometimes termed *acute* or *inflammatory* cancer, for the great vascularity suggests an inflammation (which in fact is present, caused by the irritation of cancer-cells).

These last cases are often mistaken for mammary abscesses.   Degenerations of the rapidly proliferating, ill-nourished cell-masses is common, so that cysts arise, into which hæmorrhages occur, while the skin is rapidly invaded and the tumour soon fungates through to the outside, and this not by pressure-atrophy but by invasion and necrosis.

Clinically, these cases are notable for the rapid growth of the mass, the slighter hardness, and speedy spread to the skin, deeper structures, and axillary glands.   This is still more marked in the " acute " form, in which

the skin is red, with distended veins, often infiltrated and œdematous as in acute inflammations : the absence of fever, rigors, and great malaise distinguish from pyogenic inflammations.

(4) *Adeno-carcinoma (Halstead)*. In this form the epithelial proliferation is considerable, but the cells are arranged in well-formed tubules lined with several layers of cells, in which spaces form owing to degeneration, giving the effect on microscopical examination of a slice of Gruyère cheese. The cells also are of a less atypical variety than in the more virulent forms of cancer, and hence this type is relatively benign, tending to be encapsuled and localized, infecting glands and viscera later, in spite of the great amount of epithelial proliferation.

Clinically, the tumour is better defined than is an ordinary scirrhus, the outline being sometimes irregular from the presence of small cysts : adherence to the skin and deep structures follows later. In some instances there is a discharge of blood from the nipple in cases of this sort, and some writers class these with duct-cancers, but as sections sometimes show what appears to be ordinary scirrhus and the cells are not columnar as in duct cancer,

Fig. 231. Adeno-carcinoma of the breast. The epithelium is arranged in alveoli, in the centres of which areas of degeneration are noted.

it is probable that this is often simply a variety of the spheroidal-celled form in which colloid or other degeneration has occurred, giving rise to cysts.

(5) *Cancer en Cuirasse, en Peau d'Orange*. The name indicates the property of cancer in some instances to spread in the skin and subcutaneous lymphatics very widely, while not passing into the deeper parts. This causes a thickened, indurated, leathery condition of the skin, which has been compared with pig-skin and orange-peel. The spread of the growth causes lymphatic obstruction and fibrosis of a wide area of skin, and the numerous pits on the surface represent the mouths of sebaceous and sweat glands. There are very different degrees of malignancy in this type : sometimes the atrophic form is represented, in others the acutely advancing varieties will spread widely through the skin, involving a large part of the thorax and well deserving the French title. In most instances this condition renders

operation out of the question from the enormous area of skin which would need removal.

(6) *Duct-Cancer.* Columnar-celled cancer originating in the larger ducts is distinctly uncommon ; the condition is related to papilloma of the ducts, already described, in which malignant invasion of the epithelium takes place, bleeding from the nipple being a characteristic feature. A tumour is found near the nipple formed of spaces lined with columnar cells, and into these spaces intracystic growths project ; invasion of the surrounding tissues and formation of metastases are comparatively slow, and hence the malignancy less than in several of the other forms. As mentioned, some writers class adeno-carcinoma with duct-cancer, taking the view that the former are formed from the smaller ducts, and the two conditions certainly have these points in common, viz. a great tendency to form cysts, a regular arrangement of the epithelium, and a relatively low malignancy.

SPREAD OF CANCER OF THE BREAST. This is most important when considering the most suitable form of operative treatment, which is at present the only certain method of cure. Cancer-cells spread by two methods of progress : (*a*) permeation (Handley),

FIG. 232. Cancer of the breast in section, showing indrawing of the nipple and invasion of the surrounding fat and underlying pectorals by strands of growths.

or actual growth along the tissue-spaces, smaller lymphatics, and perhaps the larger lymphatics ; (*b*) by the passage of emboli along blood-vessels (veins) and larger lymphatics.

The invasion of veins by cancer leads to embolism of the lung, and though this probably occurs tolerably widely, it is not a common mode for the spread of cancer, at all events in the early stages, since the reaction and consequent fibrosis in the capillaries of the lung, caused by the lodgment of cancerous emboli, leads to strangling and destruction of the latter (Schmidt). Invasion along the tissue-spaces and lymph-channels is associated with a reaction on the part of the tissues which destroys the greater part of the invading host, though in most instances a certain number are able to grow and produce secondary deposits. Atrophic scirrhus is an example of a

condition where the tissues are to a large extent getting the better of the
cancer cells, and this curative fibrosis may in exceptional cases go on to
complete healing. Cancer spreads along the lymphatics in two ways:
(a) as emboli passing along the large trunks; (b) by permeation, or direct
growth in a radiating manner along the
tissue-spaces and minor lymphatics. As
has already been mentioned, many lym-
phatics run along the lactiferous ducts
towards the nipple, and spread of
cancer along these periductal lympha-
tics is associated with fibrosis and con-
traction, which accounts for retraction
of the nipple, found so often in cases of
cancer. From the subareolar lymphatic
plexus, emboli pass to the pectoral,
axillary, and subclavian glands, leading,
in cases where the emboli develop,
to secondary deposits in these glands.
Lymphatic spread may also take place
along the perforating branches of the
internal mammary if the axillary lym-
phatics be blocked or where the cancer
is at the inner part of the breast without
such blocking, which accounts for the
relatively worse prognosis in such cases,
since the mediastinum is outside the
range of practical surgery in this re-
spect. Spread to the other breast is
also to be accounted for by blocking
of the direct route via the axillary
lymphatics.

Permeation. Handley has shown
that cancer-cells spread, growing by
direct extension along the small lym-
phatics of the deep fascia, the radiating
manner of this spread being demon-
strated by the manner of spread of
cutaneous secondary deposits, which
gradually spread from the centre to

FIG. 233. Cancer of the breast (section).
A large mass of growth is seen in the
upper part of the figure involving the
skin and pectoralis major. Below, the
breast tissues, the nipple and milk ducts
are unaffected.

the periphery, and by the manner in which secondaries appear in the
bones, for these are commonest in those near the breast. Secondaries
in bones are common in the ribs, sternum and vertebræ, less common
in the humerus and femur, and quite rare in the bones below the knee
and elbow; moreover, these metastases are not as in the position of
entrance of the nutrient vessels into the bones, as would be expected if
they were of embolic origin.

The spread has also been traced by Handley to the liver, along the pectoral fascia, which is continuous with the upper part of the rectus-sheath, since behind the latter is only the fold of the falciform ligament. The practical outcome of these investigations is that the deep fascia should be removed in a wide circle, having the growth as its centre; this implies removing the upper part of the sheath of the rectus.

Cancer reaches the skin by extending along the fine connective ligaments of Cooper, which retain the breast in position, and in the early stages of spread to the skin, the fibrosis in these ligaments fixes the skin locally so as to produce at first diminished mobility of the integuments and later visible dimpling of the skin, which is a useful sign in distinguishing cancer from fibrocystic degeneration.

Still later, the skin becomes one with the growth, and ulceration occurs which varies in character with the form of cancer, being a crateriform ulcer with surrounding induration and everted edges in the more slowly growing scirrhus, while, in the rapidly spreading encephaloid form, a fungating mass protrudes from the ulcerated bosom.

In other cases cancer is disseminated through the skin without ulceration, giving rise to the formation of firm, œdematous, button-like masses, the appearance of the skin being largely due to obstruction of the subcutaneous lymphatics, and resulting solid œdema of the overlying skin. Where many such buttons run together we have the form *en cuirasse*; as the spread advances the œdematous skin becomes actually cancerous. Later, spread to the liver usually produces nodes, which are palpable through the abdominal wall, while invasion of the lung causes hæmoptysis and signs of consolidation. Mention has been made of metastases in the bones leading (*a*) when localized to spontaneous fractures, or (*b*) to " mollities ossium carcinomatosa " where the condition is widespread, with wholesale crumpling up of the bone. In advanced cases general decrepitude results, known as cancerous cachexia, the patient becoming weak, wasted, anæmic, and sallow. Where the secondary tumours form rapidly and are widespread death may be relatively painless, but very often the infiltration involves the brachial plexus, rendering the latter stages extremely torturing.

Diagnosis. Early diagnosis affords the only hope of successful treatment. In well-marked cases, where the tumour is hard, fixed to the skin and deep structures, while enlarged glands are present in the axilla, and possibly there is painful pressure on the brachial plexus or cachexia from internal metastases, the diagnosis is easy but of little use to the patient. These cases must be diagnosed early, nor should the surgeon hesitate to explore in any case where there is the smallest suspicion of malignancy. Ordinary scirrhus cancer is to be diagnosed from fibro-adenoma, involution cysts with fibrosis and chronic abscess. From *fibro adenoma* the greater hardness of cancer, which in well-marked instances suggests to the touch, bone or stone, the slight mobility, ill-defined outline, and the deficient movement of the skin over the mass, will make the diagnosis (except in the uncommon condition where there is fibrosis around an

adenoma) almost certain. Dimpling of the skin over the mass, fixity of the latter to deeper structures and enlargement of the axillary glands will render diagnosis certain but will show that the possibilities of cure are dwindling.

To *involution-cysts* with fibrosis (chronic mastitis) the resemblance is closer, and both occur at the same period of life, but in mastitis the mass,

Fig. 234. Cancer of the breast. Note the size of the tumour, the marked retraction of the nipple compared with the normal side and the adhesion and dimpling of the skin over the growth.

though ill-defined, is far less hard and fluctuation may be obtained : in cancer the centre is the hardest part, while in chronic fibrosis the consistency is equal, or the centre is softer, allowing (where a cyst is present) of fluctuation to be perceived. In-drawing of the nipple is a sign of slight value since it occurs in both conditions, but if recent and of rapid development it suggests cancer. Palpation with the flat of the fingers may be of service, since mastitis, though giving the sensation of a tumour when picked up, disappears if examined with the hand and fingers placed flat upon it, unless a cyst be present. Involution changes are usually present in both breasts, but as cancer is common in such breasts the point is of little value.

The affected breast may be slung at a higher level in either condition from the increased production of fibrous tissue.

From a *chronic abscess* the diagnosis is as for involution-cysts, as the lump, though palpable with the flat hand, can be felt to fluctuate, and probably on inquiry had its origin during lactation.

Finally, it is a safe rule to regard any hard, ill-defined lump in the breast as being cancerous till the contrary is proved by exploration, and any lump in the breast of a woman over thirty-five years of age should be removed.

Diagnosis of Acute or Medullary Cancer.   This condition, when occurring in a lactating breast is likely to be mistaken for abscess, and the diagnosis only made on exploration, or even missed after this, if the surgeon does not take the precaution to incise freely or remove a piece for section where no pus is found in the supposed abscess.   In the quiescent breast the mistake is less likely to be made.   From rapidly growing sarcoma, medullary cancer may be indistinguishable, but, as the treatment is identical, this matters not.

Cysto-adenoma may be mistaken for rapidly growing medullary cancer, but the absence of infiltration of the skin in the former condition even where ulceration and fungation have occurred will distinguish.

Diagnosis on Exploration.   The naked-eye appearance of the freely incised mass will in most cases enable us to distinguish scirrhus from adenoma or mastitis, adenoma being greyish-pink and homogeneous, mastitis consisting of a mass of adult fibrous tissue with many thin-walled cysts containing clear or dark fluid, while scirrhus will show a section hollowed in the middle from the contraction of fibrous tissue and whitish in colour, dotted with many yellow points of soft material which on scraping yield a turbid " cancer juice " ; the appearance has been aptly likened to that of an unripe pear.   The want of capsule, and the manner in which the fibrous strands ramify in the breast and surrounding fat is very characteristic of cancer.   The more succulent forms of cancer resemble brain or other invading growths such as sarcoma, and being quite unlike normal or inflamed breast-tissue, will seldom cause any difficulty if freely exposed, but the precaution of examining a frozen microscopical section may occasionally be advisable before completing a wide excision.

Prognosis.   This varies widely with the type of growth and its degree of advance at the time of operation.

Acute succulent forms, especially when occurring in the lactating breast, have a very bad prognosis in spite of early operation ; on the other hand, the fibrosing, " atrophic " type may interfere little with the patient's longevity, and, very rarely, a natural cure may take place.

Adherence of the mass to deep structures renders prognosis worse, as to a less degree does involvement of the skin, and the latter condition indicates the need for a very wide removal of superficial structures.

The amount of glandular involvement has a considerable influence on prognosis ; thus Halstead gives the following percentage of cures after operation : no glands palpable in the axilla, 55 per cent. ; axillary glands

detected on palpation, 31 per cent. ; supraclavicular glands present as well, 10 per cent. Other surgeons find the percentage of cures less satisfactory, and, where the supraclavicular glands are affected, many consider the condition necessarily fatal. The prognosis of adeno-carcinoma and colloid cancer is relatively good. Statistics, however, give but a very rough idea of the matter, since the form of growth, skill of the surgeon, the type of operation performed, and the line taken with regard to excluding cases which are too advanced to render permanent cure likely, will greatly alter such figures.

There can be no doubt that palliative operations are well worth performing for this disease, on suitable cases, even where the prospect of complete cure is slight.

Treatment. The only reliable means of cure at present is removal of the growth with a wide and suitable zone of surrounding tissues where spread is probable. This is indicated in most instances, since the removal of a mass which is likely shortly to become a foul, painful ulcer is certainly correct treatment even if complete cure is unlikely.

In a few cases operation is inadvisable, as follows :

In conditions of atrophic cancer in very old persons where the progress of the growth is slow and causing little trouble. In cases of cancer *en cuirasse* or where the surrounding skin is widely involved in a cancerous erythema, operation is useless. Cases where there are marked secondary deposits in the liver, lung, bones, or in the axillary glands, involving the brachial plexus or pressing on the vessels, causing œdema of the arm, where the primary growth is but slight. Even where well-developed secondaries are present removal of the breast is sometimes indicated if foul and fungating, provided that there is some prospect of the wound healing after the operation.

Where the operation is purely *palliative*, removal of the breast with sufficient surrounding skin and possibly the pectorals, sufficient to ensure the wound remaining healed for some months, will suffice.

Where *cure* by operation is attempted the excision must be far more extensive ; the most complete operation should be at once performed, for to perform a partial operation, in the hope that enough will be removed usually proves disappointing. As will be understood from a consideration of the anatomy of the breast and the spread of cancer, the operation advised is on the following lines :

The whole breast is removed, remembering the wide extent of this. The skin around the nipple and areola and over the growth should be freely removed so as to form a circle of about six inches in diameter, of which the nipple and tumour form the centre. For practical purposes the circle is converted into an ellipse whose least diameter is that of the circle, which will give a reasonably free removal where the tumour is not very adherent to the skin. Thorough removal of the areola is essential on account of the rich subareolar lymphatic plexus. The skin round the incision should be widely undercut so that the underlying fat is removed with the breast for a large area, and the deep fascia is removed on considerably wider lines

than the skin on account of the free spread of cancer in its lymphatics. The floor of the great wound will thus have a diameter of ten to twelve inches or more, the deep fascia over this area being removed with all the super-adjacent fat. Removal of both pectorals renders this easier, besides affording free access to the axilla and ensuring complete removal of all the lymphatic glands; the fascia covering the front part of the serratus magnus, the external oblique, and the upper three or four inches of the anterior sheath of the rectus abdominis are removed in one piece with the pectorals.

The axilla is thoroughly cleared of fat and glands as far up as the passage of the vessels over the first rib, the brachial plexus and great vessels being

Fig. 235. Cancer of the male breast (left).

left, dissected clean. The axillary vein may be excised with impunity if involved in the glandular infection. Excision of both artery and vein will probably cause gangrene, and should it prove necessary to remove a portion of the artery in addition it would be essential to graft in the gap a portion of a vein, such as the saphenous.

Finally the whole mass of skin, breast, muscle, fascia, and axillary contents should be removed in one piece to prevent any escape of cancer-cells from the cut surfaces.

The operation as described has gradually been evolved and is near the limits of a patient's endurance, but in special cases portions of chest-wall may be removed, or the supraclavicular triangle cleared of glands, in addition.

Treatment of Incurable Cases. Palliative operations are occasionally advisable, as mentioned. Where operation is out of the question or
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recurrence takes place, application of heavy doses of X-rays through an aluminium filter sometimes produces excellent local effects on the skin and axilla, healing ulceration and allowing the patient to die more comfortably of internal deposits, which practically are always present at this stage. The results are, however, uncertain, and the same may be said of the application of radium or its emanation. Painful œdema of the arm from lymphatic
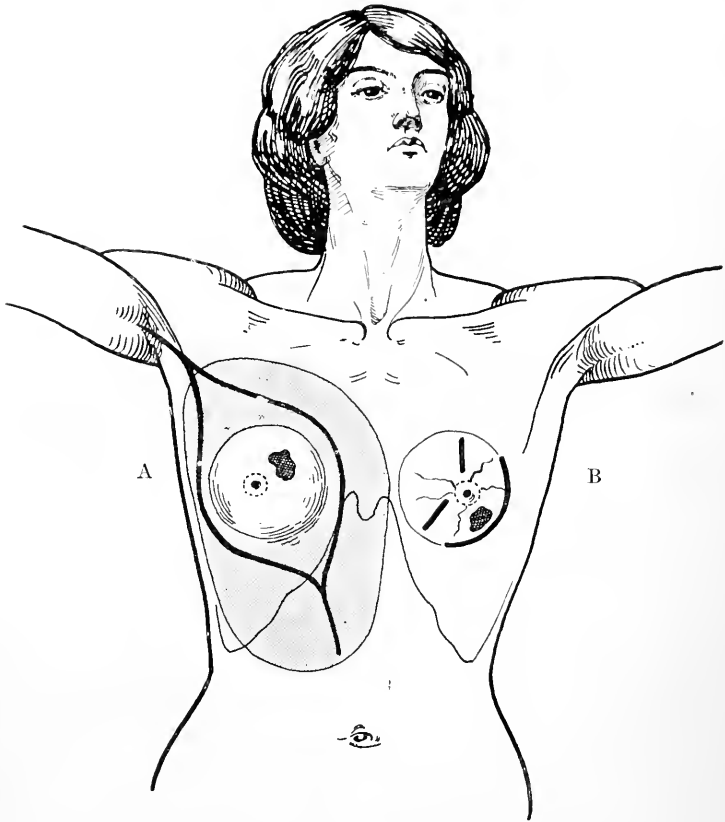
FIG. 236. A, Incision for removal of a cancer of the breast. The shaded area represents the undermining of skin and removal of deep fascia and pectoral muscles. B, Radial incisions to open abscesses and curved incision at the external and lower part for removal of innocent tumours after temporary reflexion of the breast.

obstruction may be relieved by subcutaneous insertion of silk strands (Handley), but is only likely to be successful where the obstruction is due to fibrosis following operation, and not where it is due to recurrence of the growth : in some of these cases amputation of the arm at the shoulder may be considered, as palliation.

Where the patient is near the menopause but before this period is reached, removal of both ovaries has been followed by improvement (Beatson) and may be worth a trial, but is very uncertain in its effects.

DISEASES OF THE MALE BREAST. These are uncommon with the exception of mastitis of puberty.

Of tumours cancer is the most common, fibro-adenoma being the next in frequency.

The signs and treatment are as in the female.

OPERATIONS ON THE BREAST.   Mention has been made of the importance in making incisions which radiate from the nipple when opening abscesses or to remove adenomas, in order to avoid cutting the lactiferous ducts.

Where it is particularly desired to avoid a visible scar the whole breast may be reflected by means of an incision which runs round the outer and lower border of the gland.   The breast is then turned up and inwards and the tumour enucleated from the back of the organ.   This incision is suitable for tumours which are easily enucleated ; by enlarging the incision the whole breast may be removed, dissecting it from the pectoral behind and the skin in front, leaving the nipple and areola.   Where the nipple and areola are to be removed as well an elliptical incision surrounding these is best (Fig. 236 B).

OPERATION FOR MALIGNANT DISEASE OF THE BREAST.   The main points in view in this operation have been mentioned.   The patient lying on the back with the arm on the affected side abducted to rather more than a right angle, the skin is purified over a large area, extending up on to the neck, down the arm, across the chest to the opposite axilla, half-way down the abdomen, and behind the posterior-axillary line on the affected side. The incision should be elliptical with linear extremities, the least diameter of the ellipse being not less than five inches, in early cases, and lying over the growth and areola ; in advanced cases considerably more skin should be removed.   There must be no thought at the commencement of the operation as to how the skin-flaps will meet at the finish, since skin-grafting may always be done, though in most cases the wound will come quite well together if adequate undercutting be done.   The axis of the ellipse varies with the position of the growth, and the upper linear extremity lies over the pectoral insertion and anterior third of the axilla, while the lower trends down below the ensiform cartilage.   The skin is raised inwards and outwards from these incisions till the clavicle and tendon of the latissimus dorsi are reached.   The line of cleavage between the clavicular and sternal part of the pectoralis major is defined and the tendon of the sternal part divided close to its insertion into the humerus : the axillary fascia in continuity with this divided at its outer and posterior connexion and the sternal part of the pectoralis major retracted down and inwards, partially revealing the axilla, which is crossed by the pectoralis minor.   The latter is divided close to its insertion, into the coracoid, and dragged downwards with the pectoralis major.   The axilla, thus freely exposed, is then completely denuded of fat and glands, keeping close to the main vessels, dividing, after securing with forceps, their lateral branches close to the main trunks. The intercosto-humeral and lesser internal cutaneous nerves may be disregarded ; the long subscapular nerve and subscapular artery are spared if possible, but there should be no hesitation in dividing these if close to infected parts.   The axillary contents thus dissected out are turned down

with the pectorals ; as has been mentioned, the axillary vein may also be removed with adherent glands without any danger of more than transient œdema of the arm. In this manner the axilla is cleared from the arm to the first rib, taking care to remove the sub-pectoral glands completely and not to miss any glands high up on the axillary vessels (subclavian glands). Attention is now directed to the breast ; the skin is dissected up all round the tumour and breast, raising a minimum of subcutaneous fat with it, i.e. leaving as much subcutaneous tissue as possible. This dissection should be carried widely in all directions, across the sternum till the opposite breast is encountered, outwards to the edge of the latissimus dorsi, and three or four inches below the ensiform. Next the mass of breast, pectorals and fat, with the axillary glands attached, is removed from the thoracic wall, taking with it the fascia over the anterior part of the serratus magnus, the external oblique, and the upper part of the rectus sheath, with all the fat left after reflecting the skin. The pectorals are cut close to their origins ; the perforating branches of the internal mammary will bleed smartly at this point, but are picked up as divided : owing to the plan of opening the axilla and picking up its vessels early there will be little bleeding till this point is reached. The whole mass, including the breast and tumour, is thus removed. In selected cases the operation may be extended in certain directions : portions of the ribs or their cartilages may be removed or the supraclavicular triangle cleared of its fatty and glandular contents, should enlarged glands be traced in this direction while clearing the axilla, but the above operation will suffice, for most operable cases. The large wound is kept partially covered with hot sponges, while vessels are being tied elsewhere, and this attention should be paid to any exposed area throughout the operation, to minimize shock, which is liable to be considerable. All bleeding-points are tied, and it next remains to see if the edges of the large incision will meet. Owing to the amount of undercutting already done this will usually be fairly satisfactory, but if not, more undercutting is necessary, especially under the opposite breast, till the opposite axilla is reached and the sound breast can be dislocated forwards nearly to the middle line. A few strong silk sutures are introduced wide of the edges to produce approximation and lessen the tension ; the edges will then come readily into good apposition. Drainage through a stab in the outer flap is needful for forty-eight hours as oozing is usually profuse. Abundant dressing to absorb the large effusion, which drains off at first is needed. The arm should be bandaged, while abducted to a right angle with the body, to prevent difficulty in this movement later. Where it is essential to remove a very large area of skin so that approximation is impossible the raw surface should be left to granulate for ten days, after which it is covered with a Thiersch's graft. It should be recognized that this is a large operation, and shock often considerable, but with adequate after-treatment for this complication, death from operation is most unusual. This operation fulfils with tolerable completeness the canon set for the operative treatment of malignant disease, viz. a wide removal

of the tumour, with its possible area of tissue and lymphatic spread. all in one piece.

After operation a prophylactic course of some half-dozen exposures to X-rays over the operation-wound and axilla is desirable in case any cancer-cells have escaped into the wound.

Recurrence of cancer in the scar is the result of incomplete removal, which is not always the fault of the surgeon, but such recurrences are especially prone to follow operation on insufficiently generous lines.   Second attempts are often worth a trial, for although complete cure is problematical, the date of ultimate and hopeless recurrence may be postponed and the painful tedium of a foul ,sloughy ulcer possibly delayed or even entirely avoided. Such secondary excisions may require a wide removal of the thoracic wall, and skin-grafting later ; in a few instances amputation of the upper extremity may be justifiable when useless from œdema and very painful from pressure on the brachial plexus.

CHAPTER XXXVII

SURGERY OF THE THORAX

Anatomy : Injuries of the Thoracic Wall : Compression Cyanosis : Fracture of
Ribs and Sternum : Wounds of the Thorax : Infections of the Ribs and
Sternum : Tumours of the Ribs and Sternum.

Wounds of the Heart : Pericardial Effusions : Massage of the Heart : Surgery
of the Great Blood-vessels.

Injuries of the Lungs, Hernia of the Lung : Serous Pleurisy, Empyema :
Surgery of the Lung, Phthisis, Abscess, and Gangrene.

Intrathoracic Surgery of the Œsophagus : Affections of the Mediastinum :
The Trans-thoracic Route to the Œsophagus, Lung, &c.

Anatomy. The upper inlet of the thorax is oblique, the upper margin of
the sternum being opposite the lower border of the second dorsal vertebra
and two inches in front of the latter. The manubrio-sternal junction is
opposite the fifth dorsal body and the lower end of the sternum is level with
the disc between the ninth and tenth vertebræ. The intercostal vessels
and nerves lie under cover of the upper rib of each space except where
posterior to the angle of the rib, when they cross the middle of the space,
and are liable to injury in punctured wounds of the thorax. The internal
mammary artery lies half an inch outside the edge of the sternum, behind
the costal cartilages and intercostal muscles but in front of the triangularis
sterni. The heart lies behind the cartilages of the third, fourth, and fifth
ribs and the body of the sternum opposite these, as well as a small part
of the corresponding cartilages on the right. The innominate artery, left
carotid and subclavian arteries, and the innominate veins lie behind the
manubrium sterni. The arch of the aorta and the bifurcation of the trachea
lie at the manubrio-sternal junction, corresponding behind with the fourth
dorsal spine. The apices of the lungs extend into the posterior triangle
of the neck, two inches above the anterior part of the first rib and half an
inch above the clavicle. The lower reflection of the pleura runs from the
xiphi-sternal junction along a line drawn to the twelfth dorsal spine, as far as
the middle of the last rib, the posterior portion of which is covered with
pleura. The pleural sacs overlap above the heart and may both be wounded,
while exploring from the episternal notch. The lower border of the lung
is about two inches above the reflection of the pleura, *i.e.* in a line from the
xiphi-sternal junction to the tenth dorsal spine.

General Considerations. Within the thorax lie the heart, great vessels,
lungs, bronchi, and parts of the trachea and œsophagus.

A considerable part of the surgery of the bronchi and œsophagus, such
as the extraction of foreign bodies and in the latter instance the treatment
of some forms of stricture, is performed by manipulation through the mouth

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with the bronchoscope, and by passage of bougies, &c., only a few cases being suitable for attack by trans-thoracic routes. The possibility of extensive operations inside the thorax has been increased of late years by methods of preventing collapse of the lungs after opening the pleura, of which the most practical is the use of positive pressure applied to the inside of the trachea, bronchi, and lungs by the insufflation method (Auer and Meltzer). Air containing the anæsthetic is sent down the trachea under pressure through a tube, of such calibre as to render the escape from the glottis comparatively slow, and thus enable the anæsthetist to keep the lung thoroughly expanded, though the pleura has been opened.

The following parts will be considered : (1) the thoracic wall ; (2) the heart and large vessels ; (3) the lungs and pleura ; (4) the œsophagus ; (5) the mediastinum.

(1) THE WALL OF THE THORAX. *Injuries.* These are in themselves of but slight importance for the most part, whether they be contusions, crushes, or wounds, but owing to the vital organs which fill the thorax, slight external injury may be associated with grave internal lesions : thus a small, innocent-looking stab of the thorax without external bleeding may penetrate the heart ; in other cases, severe shock and even death may result from blows on the chest, though neither before nor after death can any gross lesion be discovered—these cases are comparable with those of sudden death from slight blows on the epigastrium.

The following injuries are considered : contusions, crushes, fractures of the skeletal framework, and wounds.

(*a*) *Contusions* lead to ecchymosis as elsewhere, and are seldom of importance except that the shock may be extensive ; later simple periostitis of the ribs or sternum may result, causing prolonged pain and tenderness, sometimes terminating in suppuration.

(*b*) *Crushing Accidents* (traumatic asphyxia). The latter is a somewhat ambiguous term and the phrase " *compression cyanosis* " is more illuminating. The condition arises from severe crushes of the whole thorax with or without fracture of ribs, as in lift-accidents, being run over, the pressure of crowds, &c. After such an accident, where compression cyanosis is present there is marked shock, the face and neck of the patient are greatly congested, puffy and cyanosed, of a mottled bluish colour, with punctated hæmorrhages on the skin of the face, upper thorax, and arms. Bleeding from nose and pharynx is common and unconsciousness is usual, though not always present, while convulsions are less frequently noted. Later there will be found rales in the lungs and pneumonia may result. The explanation usually given is that the lungs and large veins are compressed, causing acute venous stasis, in the upper part of the body and head with rupture of some of the smaller veins and capillaries and over-distension of the rest : in some instances surgical emphysema is present.

Treatment is directed to the shock, which may be great ; the cyanotic condition passes off in a few days, the more severe cases die of convulsions or pneumonia ; fractured ribs or ruptured lung may need treatment.

(c) *Fracture of the Ribs and Sternum.* The ribs may be broken by direct violence, such as the blow of a fist or the kick of a horse, or indirectly in crush-accidents, in which case they give way just in front of the angle; sometimes muscular violence, such as sneezing, is responsible. The fifth to the eighth ribs are those most often broken; the upper ribs often escape owing to the protection afforded by the clavicle and scapula, the lower from their shortness and greater mobility. Any rib, however, may be broken or several may be fractured together, in severe crushes a large number on both sides often giving way. The displacement is usually slight, but the fractured ends may be driven into the lungs, liver, spleen, &c. Fracture of the ribs is unusual in young persons on account of their elasticity, much more common in the elderly and in the subjects of general paralysis.

Symptoms and Signs. There is pain at the site of fracture with acute exacerbations, causing the patient to wince visibly on deep respiration or coughing. Local tenderness is noted on pressing over the seat of the fracture or on compressing the chest-wall between points at a distance so as to cause displacement of fragments. Crepitus is fairly often noted while making the latter examination, and mobility may also be noted, especially where several ribs have given way.

Diagnosis. Where there is severe local pain on deep respiration or coughing, with a " catch " in the breathing or a wincing on compressing the chest at points well away from the fracture, the rib may be considered to be fractured, and there is no need to attempt to find crepitus or mobility.

Complications. Surgical emphysema, or effusion of air under the skin conveying a crepitant sensation on palpation, is due to a wound of the pleura and lung, but is of little significance, usually passing off in a few days. Rupture of the lung with hæmo- or pneumo-thorax, rupture of the liver with intraperitoneal bleeding, and bleeding into the pericardium must not be overlooked (*see* p. 702).

Union of fractured ribs is as a rule tolerably firm in three to four weeks.

Treatment. The affected part should be steadied with strapping and a bandage. The strapping is put on in overlapping strips two inches wide embracing the injured side, and long enough to reach the axilla on the sound side. Each strap is placed in position during expiration to ensure its fitting snugly : the bandage is a wide rib-roller. Young healthy persons may go about when strapped up, but where there is much shock the patient is confined to bed for a few days.

Old persons are kept sitting up and given expectorants to prevent hypostatic pneumonia. Complications of the lung, pericardium, liver, &c., are treated as detailed elsewhere.

Fracture of the costal cartilages, when calcified in old persons, or their separation from the rib or sternum, may occur; the signs and treatment are as for fractured ribs.

FRACTURE OF THE STERNUM. This may result from direct violence, or indirectly from hyperflexion or hyperextension of the trunk; in the former case the chin may be driven against the sternum and be the immediate

instrument of fracture. The place of fracture is usually between the manubrium and body of the sternum, or rather below this point, and is transverse in direction. Fracture of the sternum is not infrequently associated with a fracture-dislocation of the vertebral column.

Signs. Local swelling, ecchymosis, and pain on pressure, respiration, or coughing ; displacement may be marked, the lower fragment usually projecting in front of the upper. Signs of injury to the lungs or pericardium should not be overlooked ; where the upper fragment is displaced backwards there may be severe dyspnœa from pressure on the trachea.

Treatment. The fragments are replaced if necessary by extending the spine, maintaining this position by keeping the patient supine with a cushion between the shoulders, and strapping the chest as for fractured ribs. Operative replacement is indicated where the displacement persists or recurs after reduction, and causes difficulty in respiration.

(*d*) WOUNDS OF THE CHEST-WALL. If non-penetrating these are usually of slight importance, but as this complication may not be easy of diagnosis on physical signs alone, such wounds should be cleaned and carefully investigated under anæsthesia, and if found to be non-penetrating simply sutured.

Hæmorrhage from non-penetrating wounds can hardly arise from the intercostal vessels except behind the angle of the ribs, where they are no longer under cover of the upper ribs of the space in which they lie. Wounds of the intercostal space in this situation or further forward near the sternum (and then involving the internal mammary artery) may give rise to severe bleeding, the artery being difficult to secure owing to its retraction under the ribs. In such cases the wound should be enlarged and a portion of rib resected above, and if necessary below, the bleeding-point, and both ends of the bleeding vessel securely tied. Wounds of the thoracic viscera are discussed later.

INFECTIONS OF THE RIBS AND STERNUM. Acute primary infections are uncommon, but sometimes arise secondarily in sequence to acute osteomyelitis elsewhere or result from spread of an empyema. The signs and treatment are in accordance with the condition.

TUBERCULOUS DISEASE. This may arise in the body of a rib but more often at the sterno-chondral junction. The signs are those of chronic inflammatory swelling ending in the formation of a cold abscess, which has to be diagnosed from a pointing empyema.

Treatment. The abscess is opened and scraped, carious bone removed ; the wound closed and drained for twenty-four hours.

When affecting the sternum such an abscess may point in front of the bone subcutaneously, or may track back into the mediastinum and point in an intercostal space. In such cases care is needed to ascertain the true source of the suppuration and to remove it, cutting away bone freely till it is exposed.

SYPHILIS. The sternum is one of the places where gummata arise, and they usually spread forward, breaking on the skin and forming typical gummatous ulcers, which are to be distinguished from tubercle, new growth, or aneurysm of the aorta penetrating the thoracic wall.

Actinomycosis of the ribs or sternum is occasionally met with, secondary to the lungs.

TUMOURS OF THE RIBS AND STERNUM. Innocent tumours, viz. osteomas and chondromas, occur but are uncommon. Primary tumours of the ribs and sternum are usually sarcomatous, often becoming ossified and chondrified, and of chronic nature. These tumours later invade the pleura and lungs, affording physical signs in these organs, while earlier information can be obtained with radiographs.

Chronic sarcomas are distinguished from tubercle and syphilis by their hardness, irregularity, and chronicity. The less common, rapidly growing sarcoma of the sternum may pulsate, and is to be distinguished from aneurysm of the aortic arch.

Treatment. Where the growth is slow and physical signs do not point to grave involvement of the lung, the thorax should be opened under positive pressure anæsthesia, the tumour explored and removed with a portion of the thoracic wall and as much lung as necessary. In the more slowly growing forms freedom from recurrence for years may result. Operation is seldom indicated in the case of sarcomas of rapid growth.

Secondary growths originating from mammary cancer are common and appear as localized, hard nodes of the ribs and sternum, or as general osteomalacia of the bones with bending and collapse of the chest-wall.

(2) THE HEART AND GREAT VESSELS. *Wounds of the Heart.* Whether due to stabs, bullet-wounds, impalement on spikes, or laceration with shells, these injuries fall into two groups :

(*a*) The wound in the parietes and heart are both large and the cavities of the latter are freely opened. In such cases, unless the object causing the injury remains *in situ* and plugs the opening, death will inevitably result in a few seconds before there is any chance of surgical interference. Should such an object plug the wound it must on no account be removed till the thoracic wall has been widely opened and all preparations made for dealing with the wound in the heart.

(*b*) In the second group the wound in the chest-wall is small or slit-like (usually from a stab). The wound in the heart may be of some size, penetrating the cavities. The result is a rapid escape of blood into the pericardium, which fills, speedily at first but more slowly as the pressure of blood inside the pericardium interferes with the heart. The capacity of the heart is thus diminished and the escape of blood from the wound in the heart becomes slight, since the heart-beat is greatly impaired. In this condition life may be prolonged for several hours, for it is not hæmorrhage which is the danger but what may be termed " acute cardiac compression," or " heart-tamponade," the condition being akin to that found in effusion into the pericardium, of which indeed this is a variety.

In practice, it is only injuries of the second type which come under treatment, since the former variety will almost inevitably prove rapidly fatal. In most instances wounds of the heart are in the right ventricle, less often in the left ventricle or auricle. Wounds of the auricle are more

fatal than those of the ventricle, since the thin-walled auricle is less easy to suture than the more solid ventricle : where complicated with wounds of the abdominal viscera the prognosis is still worse.

Signs and Diagnosis. The patient is usually found with a small stab-wound over the præcordium. There is considerable shock, a small, weak, rapid pulse, pallor, and considerable mental irritability, the patient complaining greatly of the pain and distress. With such signs a wound of the heart is to be suspected and exploration made, since local signs are seldom prominent.

The latter include an increase in the area of cardiac dullness from distension of the pericardium, adventitious cardiac sounds on auscultation, signs of effusion into the left pleura, which is often wounded and which may lead to dyspnœa and air-hunger.

Where the pulse-rate is rising and the general condition grave an exploratory operation should be performed at once ; in less severe injuries, where the diagnosis is uncertain and the condition good it may be fair to temporize, giving morphia and carefully watching the progress, operating where the signs do

FIG. 237. Incision to explore the pericardium and heart, from a patient who was alive $4\frac{1}{2}$ years after suture of a penetrating wound of the right ventricle.

not improve. No patient should be allowed to die of effusion of blood into the pericardium without operation, since the prognosis of penetrating wounds of the heart after suturing is by no means bad.

Treatment. Since diagnosis is often uncertain, exploration of punctured wounds of the præcordium is advisable. A flap of skin should be turned either inwards or outwards over the præcordium ; outwards is best in women to avoid injury to the breast. The course of the wound is then traced through the parietes, examining the intercostal spaces and costal cartilages with a fine probe or dissecting-tool, but as the wound of a small knife may be hard to trace, it will be safest when the general condition is grave to make a definite exploration of the pericardium. The pericardium is readily exposed by removing the fourth, fifth, and sixth rib-cartilages

with half the sternum opposite to them. This may be done as an osteoplastic flap or the dense structures removed completely; the resulting scar is so strong that no inconvenience results, and a wide and speedy exposure is essential for what may be a somewhat critical operation. The pericardium is thus exposed, and will be found tense and dark in appearance from the contained blood, while the movements of the heart are slight or imperceptible. The pericardium is then opened freely by a longitudinal incision and a mixture of clots and blood escape, the pulse at once improving markedly. Rapidly sponging the pericardium free from clots, a search is made for the wound in the heart, and when found it may be temporarily closed with one or more fingers. Owing to the activity of the organ, introduction of sutures may be a little difficult. We have found the most efficient method is to clamp the edges of the wound together with tissue-forceps or the fenestrated Morrant Baker's forceps (two or three pairs will usually suffice). Interrupted sutures of fine silk are then introduced between the forceps, taking a good grip of the whole thickness of the ventricle, and when the row of these is complete the temporary hæmostats are removed. The pericardium is sponged free of clot, and extra sutures introduced if necessary to completely close the wound in the heart. The pericardium is closed completely and the flap of skin and muscle sutured in place with drainage down to the pericardium for twenty-four hours. Where the wound in the heart is plugged by a foreign body the latter should not be removed till the thorax is freely opened, or uncontrollable hæmorrhage will result.

The left pleura is probably wounded in this operation, but the lung soon expands again : of course, if the apparatus for inducing insufflation anæsthesia is to hand; this will avoid any trouble from pneumothorax. Complicating injuries of the lung, liver, or stomach should be dealt with. Where the wound heals by first intention the prognosis is good, but the occurrence of pericarditis is likely to prove fatal, which indicates the need for immediate operation, to remove any possibly infected foreign body from the pericardium.

In some instances the wound may not penetrate the interior of the heart, but hæmorrhage may come from division of the coronary vessels or a wound of the ventricular wall ; these are secured with ligatures or sutures.

PERICARDIAL EFFUSIONS. Surgical interference is sometimes needed in these affections, whether the effusion is serous or purulent, especially in the latter condition. Surgical assistance is sometimes invoked too late, because the condition of a patient with pericarditis is so grave as to render operations dangerous, while the diagnosis is often uncertain, for a dilated heart may easily be mistaken for pericarditis and a useless operation performed.

Diagnosis. In both conditions the area of cardiac dullness is increased and the pulse small, rapid and feeble, but in pericarditis the cardiac impulse will be hardly perceptible, while where dilatation is present there will be a diffuse, though feeble, impulse all over the area of increased dullness. With pericarditis the heart-sounds will be muffled and a friction-sound may be

detected, while when the heart is dilated the sounds are fairly clear and of a ticking nature. There are two methods of removing effusion from the pericardium, tapping and incision.

(1) Tapping with an aspirating-needle is applicable to clear serous effusion such as is met with in dropsical patients. The needle is inserted in the fifth space close to the left border of the sternum (to avoid the internal mammary artery), and only thrust in far enough to ensure entering the pericardium and not penetrating the heart, though if a fine needle be employed there is but little danger should this accident occur.

(2) Incision of the pericardium is indicated where the effusion is purulent or where, in rheumatic affections, the needle becomes blocked with thick lymph. Under general anæsthesia or local infiltration with novocain (in bad cases) the fifth intercostal space is opened, or if more room be needed the fifth costal cartilage removed. The triangularis sterni is divided, exposing the pericardium, when the distension of the latter, and feebleness of the cardiac movement will declare the presence of fluid. The pericardium is then opened freely, and a drainage-tube inserted. The success following this operation (which takes but little time) in some instances, should render it more widely practised, particularly where the effusion is likely to be purulent, as when following in the course of osteomyelitis ; nor should one wait till the area of cardiac dullness is manifestly increased, but as soon as increased rapidity of the pulse, præcordial pain, and a friction-sound synchronous with the heart-beat are noted, the pericardium should be opened, thus draining off the pus before the heart-muscle is greatly impaired. This course is to be strongly urged.

Pericardial Adhesions. As a result of pericarditis the adhesions binding the heart to its covering and the latter to the chest-wall may considerably embarrass the movements of the heart. For this the operation of " cardiolysis " has been devised, and consists in turning up a flap and removing ribs and cartilages over the adherent area to allow of more free action of the heart ; satisfactory results are claimed from this proceeding.

Massage of the Heart. This has been employed successfully in cases of sudden syncope under anæsthesia. The abdomen is quickly opened in the epigastrium, the hand introduced, and the heart massaged through the diaphragm against the anterior wall of the thorax.

Surgery of the Great Blood-vessels. At present surgical interference with these is confined to attempts at removing emboli from the pulmonary artery, in cases of pulmonary embolism. Suitable cases are not often found, as in most instances either death results in a few minutes, or recovery takes place with signs of infarction of some of the branches of the pulmonary arteries. Patients who live a few hours but are obviously getting worse may in future be saved by this measure, for at present it has only been successful when performed experimentally on calves (Trendelenberg).

The procedure is to expose the base of the heart by removing the third and fourth left costal cartilages, open the pericardium, and temporarily

clamp all the large vessels together as they enter and leave the heart. This allows half a minute in which to open the pulmonary artery, extract the clot with forceps, and place a temporary clamp on the wound in the pulmonary artery, when the clamp on the base of the heart is removed and circulation restored, the pulmonary artery being then sutured at leisure.

(3) SURGERY OF THE LUNGS AND PLEURA. *Injuries.* These arise in connexion with penetrating and non-penetrating wounds of the thorax, in the latter instance most usually being immediately due to tearing by the rough ends of fractured ribs.

Injuries falling short of the lung will seldom cause much damage to the *pleura*, but tearing of an intercostal artery may give rise to severe bleeding into the pleural cavity (hæmothorax); otherwise slight aseptic, traumatic pleurisy may result, with pain on respiration and a friction-sound on auscultation; this will soon clear up unless infection takes place resulting in the formation of an empyema.

SUBCUTANEOUS INJURIES OF THE LUNG. Various manifestations of this condition are found, viz. (*a*) surgical emphysema, (*b*) hæmothorax, (*c*) pneumothorax, (*d*) hæmoptysis.

(*a*) *Surgical emphysema*, known by the characteristic puffiness and soft crackling of the skin on palpation, is a fairly common complication of fractured ribs, and may spread all over the body, though usually remaining localized to the parts around the seat of injury. The condition is presumably due to laceration of both parietal pleura and lung, so that air escapes from the lung through an aperture in the thoracic wall, and so arrives under the skin. Less often the escape of air is primarily into the lung-substance, when it tracks back along the bronchi and trachea and first appears on the surface at the root of the neck; this is likely to prove a more serious condition.

(*b*) *Hæmothorax* is indicated by signs of rapidly increasing pleural effusion (dullness, loss of breath-sounds and vocal resonance, with displacement of the heart to the opposite side), together with signs of internal hæmorrhage.

(*c*) *Pneumothorax*, or escape of air into the pleural cavity, is not a common result of slight tearing of the lung, and is recognized by the dyspnœa and cyanosis, displacement of the heart to the opposite side, and hyperresonance on percussion, with loss of vocal resonance and breath-sounds, while tinkling sounds and the "bell-sound" are heard on auscultation; the latter on striking a coin laid on the thoracic wall, at some distance from the stethoscope, with another coin.

(*d*) *Hæmoptysis* varies from slight blood-stained expectoration to the coughing up of large amounts of bright red blood, in which case there is some danger of aspiration into the bronchi resulting in death from suffocation. There may be considerable shock where laceration is great.

Treatment. In the milder cases treatment will be as for fractured ribs if the latter condition be present. Treatment is seldom required for surgical emphysema unless embarrassing respiration, as when it occurs at the root of the neck, in which case it may be relieved by punctures.

Moderate hæmo- or pneumothorax will become absorbed if the patient be kept at rest in bed. Where the intrapleural effusion of air or blood causes respiratory difficulty by compressing the lung, displacing the heart, or interfering with the remaining lung, the affected pleura should be aspirated and some of the air or blood drawn off, but this drawing off should not be excessive or more effusion will follow.

Hæmoptysis is treated by injection of morphia and ergotin. At present, opening the thorax on the affected side, under insufflation-anæsthesia, does not appear to have been attempted, but this method of approaching the bleeding-point in really severe cases will probably be adopted sooner or later as technique improves.

PENETRATING WOUNDS OF THE LUNG. These usually arise from stabs or bullet-wounds, and the consequences are similar to those of subcutaneous injuries except that, where the external wound is large, the blood or air will escape, so that the pneumo- or hæmothorax will be smaller and the displacement of the heart and compression of the sound lung will be less grievous, while the risks of infection and formation of empyema will be greater. In the case of stab-wounds the results will be practically similar to those obtaining in subcutaneous injuries.

The diagnosis is made from the hæmoptysis, signs of pneumo- or hæmothorax or prolapse of lung from the wound.

Treatment. Cases of stabs or small-bore bullet wounds with slight local signs and moderate hæmoptysis are best treated expectantly, cleansing and dressing the external wound and keeping the patient quiet with morphia. In the case of large lacerated wounds thorough exploration and cleansing is needed, foreign bodies are removed, and bleeding from the thoracic wall checked as detailed under Bleeding from the Intercostal and Internal Mammary Arteries. Where there is free bleeding from the lung it will be reasonable to enlarge the wound and freely open the thorax under differential-pressure anæsthesia, find the wound in the lung, suture or ligature bleeding-points, and close the pleura without drainage, watching for the development of empyema later. In any case prolapse of the lung should be reduced after careful cleaning, or if the protruded part be gangrenous from constriction, it should be ligatured and excised.

HERNIA OF THE LUNG (pneumonocœle). This may be a sequel to wounds of the thoracic wall, the scar giving way under the pressure of coughing : apart from injury, such herniæ are found at the dome of the pleura, *i.e.* in the lower part of the posterior triangle of the neck, in emphysematous patients. The soft, pillowy swelling coming through the thoracic wall, resonant on percussion and with an expansile impulse on coughing, is characteristic. Where such a hernia tends to increase, elastic pressure with pad and bandage or some form of truss should be arranged over the weak spot.

Finally, in the case of wounds of the chest, especially of its lower part, it should be remembered that the upper abdominal viscera are within the thorax though below the diaphragm, and may readily be injured by

fractured ribs or in penetrating wounds, the stomach. liver, spleen, colon and pancreas being especially liable to be affected. Hence in cases where an abdominal lesion is suspected, laparotomy should be performed and attention directed to the liver, stomach, and spleen.

AFFECTIONS OF THE PLEURA

Surgery of the pleura is chiefly concerned with removing effusions which will not subside, under medical treatment.

Pleural effusions may be divided into serous and suppurative.

(a) Serous effusions are of varying origin, including (1) the common clear, pleural effusion (serous pleurisy) which is nearly always tuberculous in origin ; (2) effusion in the course of general anasarca from renal or cardiac disease ; (3) effusion due to pressure on the vessels in the roots of the lungs by mediastinal tumours or aneurysms of the aorta.

(b) *Suppurating Pleural Effusion* (empyema). This most commonly arises from pneumococcal infection as a sequel to acute lobar pneumonia, but also follows other forms of pneumonia, influenzal, typhoid, pyæmic, tuberculous, as well as bronchiectasis and pulmonary abscess ; or by spread of infection from some suppurative focus in the abdomen, as a liver-abscess, splenic abscess, subphrenic abscess, &c. For a full account of both forms of pleural effusion the reader is referred to works on internal medicine ; we can here merely detail some of the practical points of their surgical treatment.

Treatment. (a) SEROUS PLEURISY. There is some difference of opinion as to the merits of removing the effusion in tuberculous cases, for with minor degrees of effusion, the pressure to which the lung is subjected appears to have a beneficial effect on the course of the disease in the lung.

Where, however, there is gross effusion and the chest dull nearly to the clavicle with displacement of the heart and dyspnœa, few will persist in conservative measures even where the effusion is tuberculous, and where it is due to one of the other causes removal of the fluid is indicated much earlier.

As in many instances the diagnosis is uncertain till fluid is withdrawn, the chest should first be aspirated for diagnostic purposes with needle and syringe, as fairly often where the signs point to a serous effusion the latter proves to be purulent. Aspiration should be done at the place where the presence of fluid is suspected from the physical signs, viz. dullness, loss of breath-sounds, and impaired vocal resonance. In general the seventh intercostal space, close to the angle of the scapula, is a good place for an exploring puncture, first taking care that the needle is pervious and the syringe in good working order.

Where serous fluid is found and it is decided that drawing it off is necessary, this is best done, not with any aspirating apparatus, but simply by inserting a fine trochar and cannula with a rubber tube attached to the latter to conduct the fluid away (Southey's tubes for draining anasarca are

useful). The fluid is allowed to drain till no more will escape or till coughing ensues from the irritation of the tube. This may take some hours, and is repeated in cases other than of tuberculous origin as required.

(b) EMPYEMA. The purulent effusion may fill the whole pleural cavity or be localized to some part by adhesions (encysted empyema). but most cases will be loculated by ad-

hesions if allowed to per-
sist and become chronic.
In a few instances such a
localized empyema works
its way through the wall
of the thorax and appears
on the surface ; this is
most usual where the em-
pyema is loculated in the
upper part of the thorax,
and these pointing empy-
emas, or, as they are called,
"empyemata necessi-
tatis," are usually found
in the axilla or in the
pectoral region, the former
position requiring to be
distinguished from an
axillary abscess. In some
cases, on the left side,
the cardiac impulse is
transmitted through the
collection of fluid to the
outside (pulsating empy-
ema). In recent cases
the lung will expand as
soon as the pus is drained
off, but if allowed to per-
sist, the exudation on the
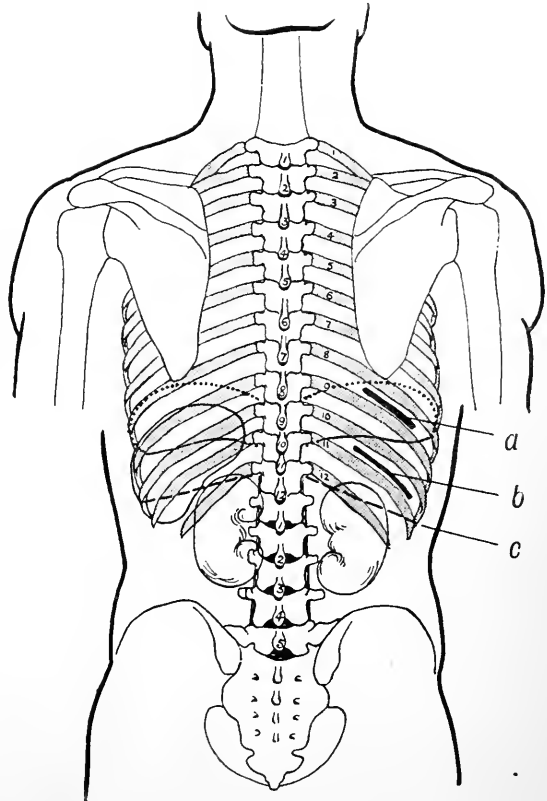
FIG. 238. *a*, Incision for empyema. *b*, Incision for sub-phrenic abscess. *c*, Line of pleural reflexion ; the solid line above this is the lower limit of the lung, and the second dotted line is the diaphragm.

visceral pleura becomes converted into fibrous tissue, binding down the lung and rendering expansion impossible or most unlikely ; fibrosis of the lung may occur as well. If left untreated, death may result from com-pression of the lungs, displacement of the heart, and twisting of the large vessels, or general septicæmia may follow. Occasionally empyemas burst into the bronchus and pus is coughed up, sometimes with cure ; more often, however, the patient is suffocated or fatal aspiration-pneumonia results ; perforation through the diaphragm into the abdomen is uncommon.

Diagnosis. The signs are those of pleural effusion with swinging pyrexia, sweats, wasting, and earthy pallor, but the diagnosis is often doubtful until the exploring syringe has brought forth pus, the character of which gives

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some indication of the prognosis (as the pus is often thick the exploring needle should be of large bore). Prognosis in the pneumococcal cases is fairly good if unilateral, less so where the condition is present on both sides. Where the infection is streptococcal, as after scarlet fever, the outlook is less good, while empyema following subphrenic abscess, influenza, pulmonary abscess, and where putrefactive organisms are present carry a high mortality. Early evacuation of pus is essential, and this implies early diagnosis, so that suspicious cases should be freely " needled " for diagnostic purposes.

Treatment. Free drainage should be established. In most instances a portion of a rib should be resected, though where the patient's condition is very grave, an intercostal space should be incised under local anæsthesia, a flat silver tube inserted (Turner) for a few days, and the larger operation performed when the patient's condition is better. As a general rule it is best to drain from behind, removing part of the eighth or ninth rib behind the posterior axillary line. Where the condition of the patient is good a general anæsthetic may be given, but this should not be pushed at all deeply ; the coughing reflex should not be abolished. Where there is any doubt about the patient's standing a general anæsthetic, novocain should be employed both locally in the skin over the rib, and injected above and below the rib close to its angle half an hour before, to anæsthetize the intercostal nerves of the spaces above and below the rib which is to be removed.

The position of the patient is important : the sound side is uppermost, the patient being turned over nearly on the face, which affords easy access to the posterior part of the under side of the thorax.

Operation. Having verified the diagnosis with an exploring-needle through the space above the rib which is to be excised, a three-inch incision is made over the latter, the latissimus dorsi divided, and the periosteum cleared off the part of the rib exposed with a chisel : the intercostal vessels are carried off with the periosteum. About two inches of the rib are removed with bone-forceps, the underlying pleura (which may be very thick) is incised, and the pus allowed to escape ; the amount of this may be only a few ounces, but we have removed as much as six pints from an adult. A finger is inserted into the pleural cavity to remove clots of lymph and free adhesions, and the lung in favourable cases can be felt rapidly expanding as the patient coughs ; a wide drain-tube is inserted just through the thoracic wall.

After-treatment. The patient sits up as soon as possible to increase the drainage. Great care should be taken of the tube (the flanged variety is useful), as empyemas are traps into which many drain-tubes fall, if precautions be not taken, and extraction is not always easy. Later suction with Klapp's bell will assist in evacuating pus, and as the patient convalesces breathing exercises should be practised regularly. The method of blowing into bottles filled with water is laborious and ineffectual ; much better is it to practise deep breathing to increase the expansion of the lung. Irrigation

of the empyema cavity is inadvisable except in foul cases, and even then not until some days have elapsed, so that adhesions around are tolerably firm. Fatal results from early irrigation are recorded. Localized empyemas should, of course, be opened where they are found, and at the lowest point to secure good drainage.

DOUBLE EMPYEMA. It is not advisable to operate on both sides at once. The side where the effusion is greatest should be opened and drained first, while the less affected side should be tapped at first and opened after a few days, when the lung on the first side has recovered some of its function.

TUBERCULOUS EMPYEMA. This may result from the rupture of a phthisical cavity into the pleura, in some cases with escape of air as well (pyo-pneumothorax). In these cases mere drainage will be of but slight benefit owing to the fibrous condition of the lung, bound down by adhesions. Hence, if operation be undertaken, to prove effective, it will be of the same type as is performed for those empyemas which will not heal, viz. removing the ribs so that the thoracic wall collapses into the cavity, or perhaps removing part of the lung ; cases suitable for such measures are not common.

Complications. In most instances the drainage-tube can be dispensed with after a few days, and if suppuration persists more than a few weeks there must be some cause requiring treatment, such as caries of a rib, tuberculosis, a drain-tube lost in the pleural cavity, inability of the lung to expand from dense adhesions and thickening of the visceral pleura, binding it down to the wall of the thorax. The underlying cause of failure to heal is discovered by investigation of the sinus. Carious ribs are excised, drain-tubes detected by X-ray examination and removed, &c.

Treatment of Chronic Empyema, with Sinuses and Cavities which will not heal. Small cavities may be curetted and filled with bismuth paste. In the case of larger cavities the bony framework of the chest-wall is removed so that the soft parts can fall in and fill the cavity (Estlander, Schede). Such operations are undertaken when the healing of an empyema is at a standstill, *i.e.* about three months after the original operation for empyema. The size and position of the cavity should be determined before operation by filling with bismuth-paste and radiographic examination, as well as by percussion and auscultation. Where the cavity is small the method of Estlander may be used. An incision is made over the cavity in the direction of the ribs, the soft parts are retracted, and portions of two or three ribs removed with the periosteum so that the soft parts readily fall into the cavity. Where the cavity is large the method of Schede is advisable : a flap of soft parts is turned up over the cavity and then sufficient ribs resected. As, however, the size of the cavity may not be easy to ascertain from outside, the modification suggested by Jacobson is to be recommended. This consists in making the apex of the flap below the lowest probable extent of the empyema, resecting one or more ribs so as to obtain good access and thus explore the cavity. The flap of soft parts is then cut, suitable in size and direction to allow of the thoracic wall falling in, which will obviate unnecessary removal of ribs. Having determined the extent of the cavity

and reflected a suitable flap, the outer wall of the cavity is resected entire, removing ribs and intercostal muscles with the thickened pleura (this may be half an inch or more in thickness). The division is made with sharp bone-forceps. The periosteum should be removed or new bone will be laid down rapidly and impair the flexibility of the flap, and much time is saved by removing the whole wall of the thorax with the pleura. The cavity is cleaned with iodine solution and the flap sutured back in place, being pushed with dressings into the large cavity; drainage for a few days is needed.

Decortication of the lung, *i.e.* removing the thickened visceral pleura, is advocated by some surgeons, either alone or in addition to the above operation. But the prospects of these lungs expanding is but slight.

Lateral curvature of the spine often follows such delayed healing of empyemas, and is treated by exercises.

SURGERY OF THE LUNG

Operative measures on the lungs consist of (*a*) *pneumonotomy*, or incision of the lung to evacuate pus or to extract foreign bodies, hydatids, &c.; (*b*) *pneumonectomy*, or removal of part of the lung for tumours or other disease.

Some of these operations are of recognized value, others are still *sub judice*, while others, again, seem hardly reasonable.

The pathology and diagnosis of affections of the lungs are described in works on internal medicine; it is only possible here to touch on a few points of surgical treatment.

PHTHISIS. The results of hygienic treatment are so good in early cases and operative measures so hopeless in those more advanced that surgical measures seem distinctly out of place, and the only plan worthy of note is the artificial production of pneumothorax, based on known good results due to, or at any rate following, a pneumothorax naturally occurring in the course of phthisis. The pleura has been punctured and nitrogen injected (this gas is used because it will be very slowly absorbed). This plan is comparatively mild and is mentioned favourably, but further results are needed before it can be regarded as a definite method of treatment.

Excision of tuberculous apices is far more drastic, than is necessary in cases which heal so well on general treatment. Drainage of cavities is not sufficiently successful to be recommended. Resection of the upper costal cartilages to allow of the lung partially collapsing is lauded by enthusiasts.

ACUTE INFECTIONS OF THE LUNG; ABSCESS AND GANGRENE. Surgery of these conditions is on a more assured basis, as the results if left alone are so bad that operation is indicated in many cases, and the results are very fair.

(*a*) *Pulmonary Abscess.* Abscess of the lung may result from the presence of foreign bodies in the bronchi, after pneumonia, from suppurating hydatids, or infective emboli.

The admirable results obtained with the bronchoscope in extracting foreign bodies from the bronchi have been already mentioned.

The diagnosis of pulmonary abscess is made by the persistence of localized consolidation or the development of cavitation following an attack of pneumonia or after inhaling a foreign body, together with purulent sputum, which is offensive but not to such a degree as where gangrene is present, and swinging pyrexia. Fragments of lung and elastic tissue in the sputum are characteristic. Radiographic examination may be of assistance in localizing the lesion. Where the abscess has burrowed into a bronchus and is being coughed up it is well to defer operation for a few days, as such cases not infrequently clear up spontaneously, but if the purulent expectoration persists for more than a week without improvement operation should no longer be delayed. The abscess being located, the thorax is opened under differential-pressure anæsthesia, sufficient ribs being resected to afford a good exposure. The lung around the abscess is sutured to the parietal pleura and the abscess opened, explored, sloughs removed, and a drainage-tube inserted.

(b) *Gangrene of the Lung.* This may follow lobar pneumonia, aspiration-pneumonia, foreign bodies in the bronchi, bronchiectasis, embolism of branches of the pulmonary artery.

The diagnosis is made on signs of consolidation or cavitation, with great depression from septic absorption ; the sputum is copious and most offensive, separating in the receptacle into an upper frothy layer, a middle brown watery layer, and lower layer of greenish-brown sediment containing disorganized lung-tissue. The localization may be completed with X-rays, and the treatment is similar to that for pulmonary abscess but with a more free exposure, the gangrenous part being excised and the resulting cavity drained.

HYDATID DISEASE OF THE LUNG. The signs are fluid in the pleura and displacement of the heart. The diagnosis is seldom made before an aspirating-needle is inserted, when the perfectly clear fluid and the hooklets contained therein disclose the condition at once. Operation should follow immediately on diagnosis, lest the cyst burst into a bronchus with fatal result.

The thorax is opened as before, the lung sewn to the parietes and then opened, the cyst being turned out ; drainage for a few days is indicated.

BRONCHIECTASIS. Dilatation of the bronchi associated with fœtid, purulent bronchitis is not often suitable for surgical measures, but if localized to a part of the lung resection of this part may be possible.

NEW GROWTHS OF THE LUNG. Even when primary these are seldom operable, and never if metastatic from a distance.

Where spreading in from the chest-wall and of slow-growing tendency removal of the affected part may be profitable, together with a part of the thoracic wall.

(4) INTRATHORACIC SURGERY OF THE ŒSOPHAGUS. A large portion of the œsophagus is exposed in the thorax when the pleural cavity is opened

under insufflation-anæsthesia by a rib-spreading method (*see below*). This allows a free examination of the intrathoracic part of the œsophagus and should prove useful for removing foreign bodies hopelessly impacted in the thoracic œsophagus. New growths may also be removed, though but one successful case is reported up to date; the difficulty of dealing with the severed ends of the œsophagus, and the resulting empyema, still baffles the surgeon, while restoring the continuity of the tube and so avoiding a gastrostomy is one of the surgical problems of the present day.

FIG. 239.   Transpleural exploration of the thoracic viscera.   *a*, Incision along the 4th intercostal space.   *b*, Lower margin of the lung.   *c*, Skin incision.

(5) AFFECTIONS OF THE MEDIASTINUM. The spread of acute infection from the deep tissues of the neck to the superior mediastinum has already been described, and in most instances, exploring from the neck in the direction of the infection will provide adequate drainage. Where the infection reaches the anterior mediastinum, as evidenced by pain behind the sternum and bulging over intercostal spaces on either side of this, drainage should be arranged at the part thus indicated, incising an intercostal space, removing a rib-cartilage or part of the sternum, as seems necessary. Infection in the posterior mediastinum resulting from ulceration or injuries of the œsophagus, or consecutive to spinal caries, may be reached by removing the posterior part of one or more ribs.

THE TRANSPLEURAL ROUTE TO THE ŒSOPHAGUS, LUNG, BRONCHI, AND HEART. Under positive-pressure anæsthesia a large flap is turned up from the second costal cartilage in front to the fourth rib behind; the apex of this reaches nearly to the costal margin. This flap is turned up, carrying with it the latissimus dorsi (cut across) and the scapula. The fourth intercostal space is opened from the front to the angle of the ribs and the fourth and fifth ribs are forced apart with a suitable rib-spreading retractor,

thoroughly opening the pleural cavity and exposing the lung, pericardium, and side of the œsophagus. The shock is not great, and lung may be resected, portions of the œsophagus may be removed, or foreign bodies extracted from the latter or from the bronchi. The lungs are walled off with packs of sterilized silk-tissue, soaked in liquid vaseline, to prevent adhesions later.

The danger of opening the œsophagus and bronchi is that empyema will result. This is certainly the most efficient method of exploring the interior of the thorax, but whether the results will often be repaying is questionable, since the pleura is a far less efficient aid to healing than is the peritoneum, in the larger operations inside the abdominal cavity. Still the success already attained promises better results in the future.

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Principles and Practice of Lawyers